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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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April 24, 1969

OPERATIONAL LM ABORT AND RESCUE PLAN FOR APOLLO 10 (MISSION F) SUPPLEMENT TO VOLUME I NON-TIME-CRITICAL PROCEDURES SPECIFIC CASE DATA

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MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
Orbital Mission Analysis Branch
MISSION PLANNING AND ANALYSIS DIVISION

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PROJECT APOLLO

OPERATIONAL LM ABORT AND RESCUE PLAN FOR APOLLO 10 (MISSION F) SUPPLEMENT TO VOLUME I - NON-TIME-CRITICAL PROCEDURES - SPECIFIC CASE DATA

By James D. Alexander, Jerome A. Bell,
Allan L. DuPont, and Harold O. Spurlin
Orbital Mission Analysis Branch

April 24, 1969

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Approved: _____
Edgar C. Lineberry, Chief
Orbital Mission Analysis Branch

Approved: _____
John P. Mayer, Chief
Mission Planning and Analysis Division

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OPERATIONAL LM ABORT AND RESCUE PLAN FOR APOLLO 10 (MISSION F) SUPPLEMENT TO VOLUME I - NON-TIME-CRITICAL PROCEDURES - SPECIFIC CASE DATA

By James D. Alexander, Jerome A. Bell, Allan L. DuPont, and Harold O. Spurlin

SUMMARY AND INTRODUCTION

This document is a supplement to Volume I (Non-time-critical Procedures) of the Operational LM Abort and Rescue Plan for Apollo 10 (Mission F). The purpose of this supplement is to present specific data for nine abort and rescue cases and for the nominal case on which the abort and rescue data are based. Tabular summaries of the rendezvous sequence (tables I through X) and relative motion plots (figs. 1 through 10) are presented for the 10 cases. The specific data presented for each case include various forms of the state vectors instantly before and after the impulsive equivalent of each maneuver, a detailed maneuver table for each maneuver, lighting (sunrise/sunset) tables, and MSFN tracking (AOS/LOS) tables. For the nominal case, state vectors are also shown at approximately 20 minutes prior to each maneuver.

The nominal case is based on the May 17 launch date and the 34° E lunar landing site. Most of the presented data were generated prior to the nominal change to the May 18 launch date, and an update of these data could have required 2 to 3 weeks. However, it is emphasized that, relative to the start of the rendezvous (i.e., DOI), the rendezvous (relative) profile would vary negligibly as a function of the launch data. That is, the ΔV's, Δt's, orbits, relative motion, and lighting (relative to maneuver points) are essentially the same regardless of launch date. The specified inertial vectors and the ground elapsed times of the maneuvers and MSFN AOS/LOS times do vary as a function of the launch date (or landing site). However, the data presented in this supplement should suffice for accurate various detailed analyses (concerning time lines, consumables, propulsion, etc.) for the May 18 launch

date. Further, from a vehicle-to-vehicle standpoint, the presented data are applicable for various simulator analyses.

SYMBOLS AND DEFINITIONS

General Symbols

A	semimajor axis, ft
E	eccentricity
I	inclination, deg
G	argument of perigee, deg
H	inertial longitude of the ascending node, deg
L	mean anomaly, deg
APS	ascent propulsion system
C1	phasing maneuver (DKI)
CDH	constant differential height (coelliptic) maneuver
CSI	coelliptic sequence initiation
CSM	command and service modules
Δh	coelliptic differential altitude
DOI	descent orbit insertion
DPS	descent propulsion system
ER	earth radius or radii
ER/HR	earth radii/hour
F	true anomaly, deg
F.T.	full throttle

H	height maneuver (DKI)
HA	apocynthion, n. mi.
HP	pericynthion, n. mi.
HT	height, n. mi.
INS	insertion maneuver
LM	lunar module
LUNAR R	lunar radius or radii
LUNAR R/HR	lunar radii/hour
PER	orbital period, n. mi.
PDI	powered descent initiation
PHA	phasing maneuver
RCS	reaction control system
SPS	service propulsion system
SR	coelliptic maneuver (DKI)
TPI	terminal phase initiation
TPF	terminal phase finalization
U	argument of latitude, deg
V	inertial velocity, fps
G	flight-path angle, deg
P	heading, deg
R	radius from center of moon, ft
LO	longitude, deg
LA	latitude, deg
X, Y, Z	rectangular position coordinates, ft
XD, YD, ZD	rectangular velocity coordinates, fps

Symbols for the Mission Planning Detailed Maneuver Tables

Display quantity	Definition
C STA ID	standard identification for CSM vector used in generation of maneuver
GMTV	Greenwich mean time of CSM vector, hr:min:sec
GETV	ground elapsed time of CSM vector, hr:min:sec
CODE	code assigned to the maneuver in the MPT. The first letter is either C or L, meaning CSM or LM. The second letter is the thruster identification, R - RCS, S - SPS, D - DPS, and A - APS. The third letter identifies attitude mode used, S - SCS, G - Guided, M - Manual, and X - external ΔV. Next is the maneuver number in the MPT and then the maneuver identification; i.e., NCC, NSR, TPI, etc.
L STA ID	standard identification for LM (S-IVB) vector used in generation of maneuver
GMTV	Greenwich mean time of LM (S-IVB) vector, hr:min:sec
GETV	ground elapsed time of LM (S-IVB) vector, hr:min:sec
REF	prints out either EARTH or LUNAR depending on the reference body
X STA ID	standard identification for the CSM or LM vector that was used to generate the frozen profile of the maneuver displayed in the DMT
GMTV	Greenwich mean time of frozen maneuver vector, hr:min:sec
GETV	ground elapsed time of frozen maneuver vector, hr:min:sec
GETR	reference ground elapsed time for phase elapsed time, hr:min:sec
WT	weight of the total maneuvering prior to the maneuver, lb
WC	CSM dry weight plus unusable propellant, lb

Display quantity	Definition
WL	LM dry weight plus unusable propellant, lb
WF	weight prior to the maneuver of the engine performing the maneuver, lb
GETI	ground elapsed time of ignition, hr:min:sec
PETI	phase elapsed time of ignition, hr:min:sec
DT B	duration of main engine burn, min:sec
DT U	duration of ullage, sec
DT TO	effective duration of main engine tailoff, sec
DV TO	velocity increment of main engine tailoff, fps
REFSMMAT	identification of REFSMMAT used to compute gimbal angles
DEL P	main engine pitch gimbal trim angle from the electronic null position for the SPS or the positive handover position for the DPS, deg
DEL Y	main engine yaw gimbal trim angle from the electronic null position for the SPS or the positive handover position for the DPS, deg
DVM	total velocity increment of maneuver, fps
DVREM	total velocity remaining after maneuver, fps
DVC	total velocity increment, less tailoff to be applied along the vehicle X-axis, fps
VGX, VGY, VGZ	prethrust $\bar{V}g$ output from the guidance equations displayed in IMU coordinates; computed based on a free-flight vector at GETI, fps
OY, IP, MR	outer, inner, and middle gimbal angles at ignition (0° - 360°), deg. These labels will be dynamic and displayed as follows: for the CSM, roll, pitch, yaw; for the LM, yaw, pitch, roll; for the S-IVB maneuver, these will be CSM gimbal angles

Display quantity	Definition
YB, PB, RB	FDAI angles, deg. These are the same as the gimbal angles yaw, pitch, roll for CSM maneuvers, but correspond to pilot yaw, pitch, roll for LM maneuvers
YH, PH, RH	local vertical/local horizontal yaw, pitch, and roll at ignition, deg
VF, VS, VD	components of VGX, VGY, VGZ transformed to local vertical coordinates defined at GETI, fps
DH	differential altitude at cutoff between LM (S-IVB) and CSM displayed in n. mi. and positive when maneuvering vehicle is below
PHASE	phase angle at cutoff between LM (S-IVB) and CSM measured from chaser to target in the direction of motion (0° - 360°)
PHASE DOT	rate of change of phase angle at cutoff, positive when PHASE is decreasing, deg per orbit
WEDGE ANG	wedge angle at cutoff between CSM and LM (S-IVB) orbits, deg
YD	cross-range distance from CSM orbit to LM at insertion following ascent, n. mi.; will be zero for any maneuver other than the ascent maneuver
H BI	altitude of maneuvering vehicle above spherical earth or moon (defined by REF) at ignition time, n. mi.
P_c BI	geodetic latitude of maneuvering vehicle at ignition while in earth orbit; otherwise, geocentric latitude, deg
L BI	longitude of maneuvering vehicle at ignition, deg
F BI	true anomaly of maneuvering vehicle at ignition, deg
UNTIL	lighting conditions at GETI, hr:min until day/night
HA	altitude of next apoapsis after cutoff above spherical reference, n. mi.
HP	altitude above spherical reference of next periapsis after cutoff, n. mi.

Display quantity	Definition
L AN	longitude of next ascending node after cutoff, deg:min
E	orbital eccentricity after cutoff
I	trajectory inclination to earth or moon (defined by REF) resulting from maneuver, deg
WP	argument of perigee or pericynthion (defined by REF) resulting from maneuver, deg
VP	velocity at next pericynthion after maneuver for maneuver performed while in lunar orbit, fps
THETA P	central angle between radius vector passing through the next pericynthion after cutoff and the lunar landing site at the time of next pericynthion displayed in degrees and negative when the landing site is beyond pericynthion, deg; driven only for maneuvers while in lunar orbit
DELTA P	wedge angle between orbit at cutoff and a parallel plane passing through the lunar landing site, deg; driven only for maneuver while in lunar orbit
P LLS	latitude of lunar landing site as a result of the powered landing maneuver, deg:min
L LLS	longitude of lunar landing site as a result of the powered landing maneuver, deg:min
R LLS	radius of lunar landing site, n. mi.
TARGETS	these quantities are driven according to the type of maneuver displayed. They are as follows.
1. PGNS	primary guidance and navigation system
EXT DV	ID for vehicle doing the external ΔV maneuver
GETI	ground elapsed time of ignition, hr:min:sec
VX, VY, VZ	components of external ΔV vector required to target the onboard AGS external ΔV guidance for maneuver execution, fps

Display quantity	Definition
2. AGS	abort guidance system
EXT DV	ID for vehicle doing the external ΔV maneuver
GETI	ground elapsed time of ignition, hr:min:sec
VX, VY, VZ	components of external ΔV vector required to target the onboard AGS external ΔV guidance for maneuver execution, fps
3. LAMBERT	
GETI	ground elapsed time of ignition, hr:min:sec
T F	time of flight from ignition time to the target vector, hr:min:sec
X, Y, Z	inertial target vector, ft
C	cross-product steering constant
4. MVR	ID indicating whether the maneuver in the table is the CSI, CDH, or TPI maneuver of the concentric flight plan
GETI	ground elapsed time of ignition, hr:min:sec
APSIS	number of apsis crossings between the proposed CSI and CDH maneuver which is an uplink parameter to the onboard computer program that computes the onboard concentric flight plan
ELEV	desired or actual elevation angle (up or down) from the chaser to the target vehicle at TPI of the current concentric flight plan, deg
TPI	desired ground elapsed time of the TPI maneuver of the current concentric flight plan, hr:min:sec
DT	transfer time between TPI and intercept of the current concentric flight plan, min:sec
OPTION	code (ELEV or TIME) indicating whether the concentric flight plan is targeted for an elevation angle or a time at TPI

Definitions

abort	nonnominal rendezvous sequence for which the LM is the totally active vehicle; that is, the CSM makes no rendezvous maneuver
abort initiation	first abort maneuver in an abort sequence
centric	selenocentric

elevation angle	angle measured (starting upward) from a vehicle's local horizontal in the direction of motion to the line of sight to the other vehicle
graphic	selenographic
height adjustment maneuver (H)	external maneuver which sets up the establishment of the desired coelliptic Δh 180° later
phase adjustment maneuver (C1)	external maneuver which establishes the desired phase (central) angle at the subsequent maneuver
rescue	nonnominal rendezvous sequence for which the CSM performs one or more of the rendezvous maneuvers
rescue initiation	first rescue maneuver in a rescue sequence; in simulations, this maneuver is referred to as rescue 2
theoretical ΔV	Keplerian impulsive ΔV; for example, the TPF ΔV for the impulsive intercept velocity match

EXPLANATION OF DATA

The computer program used to generate the presented data is equivalent to the Real-Time Auxiliary Computer Facility program. Vectors are not shown at the LM staging for the cases for which the LM stages. In fact, the staging sequence is not simulated, although the LM weight is changed. The normal staging sequence currently assumed involves thrusting approximately 2 fps in one direction, staging, and then thrusting the same ΔV in the opposite direction (ascent stage only). For the purpose of these data, the weight change at the staging time should suffice. For most of these cases, staging is assumed to occur approximately 10 minutes prior to the first attempted APS or RCS-interconnect burn. The exceptions are the zero and partial phasing cases, for which staging is assumed to occur at the nominal phasing time. Also, for the rescue after a 20-fps DOI, it is assumed that the LM remains unstaged.

The relative motion during the coelliptic phase (CDH-to-TPI) shows a noticeable variation in the coelliptic Δh for cases where the target orbit is relatively highly elliptical. This variation is caused by the fact that the curvilinear radial displacement is the difference in the altitudes of the vehicles along the two radius vectors, not the differences in the altitudes for phase match (i.e., the altitude difference of the two orbits along the same radius vector). This phase match Δh is nearly constant with time and is approximately equal to the targeted

coelliptic Δh. For a circular target orbit, the curvilinear and phase match Δh's during the coelliptic phase are equal.

The coordinate-centered vehicle in each relative motion plot is the assumed target vehicle for terminal phase. Even when the LM performs terminal phase only, the relative motion for the entire rendezvous is CSM centered.

The case that shows a CSM takeover after a nominally-attempted zero CSI is based on a CSM CSI which is targeted 3 minutes after the LM CSI time. A decision was made recently to target the CSM CSI at the nominal LM CSI time and then, if a CSM takeover were required, to apply the corresponding ΔV as soon as possible. The effects of this recent procedure have not been determined fully at this time, but it is assumed that the resultant situation (coelliptic Δh, CDH time, and TPI time) would not vary significantly from that for the presented case. The equal-time targeting of the CSM backup maneuver also applies for CDH and TPI.

Very close approximations of ground elapsed times of the various maneuvers and other points of interest can be determined for the May 18 launch date by addition of the applicable DOI-referenced Δt (for the presented data) to the May 18 DOI time.

Some of the maneuver terminology in the data printout is different from the normal maneuver terminology used in this report. For each case, the printout maneuver terminology which differs from the normal terminology is given in parentheses with the normal terminology.

In the lighting tables, the sunrise and sunset times which are most accurate (i.e., which reflect all previous maneuvers) are checked. In the MSFN AOS/LOS tables, data for the last tracking period per station shown for a given pass reflects all of the previous maneuvers. Some of these tables show only the three deep-space stations while some of the tables show several additional stations. This difference is caused by the way the decks were set up to make the runs.

CONCLUSIONS

The presented specific cases are representative of the various types of abort and rescue situations that could occur for various failures during the nominal rendezvous of Apollo 10 (Mission F). Although the data are based on the May 17 launch date, they should suffice for the various May 18 launch date time line, consumables, and propulsion analyses, and, from a vehicle-to-vehicle standpoint, for certain simulator analyses. The relative rendezvous profiles are essentially the same regardless of the launch date or lunar landing site.

1.0 NOMINAL RENDEZVOUS PROFILE

TABLE I.- SUMMARY FOR NOMINAL SEQUENCE OF EVENTS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	DOI	DPS (40%)	--
LM	Phasing (PHA)[b]	DPS (F.T.)	2/3
LM	Insertion (INS)[b]	APS	5/6
LM	CSI	LM RCS	1/2
LM	CDH	LM RCS	1/2
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI at the nominal time.

[b]The printout maneuver terminology is given in parentheses.

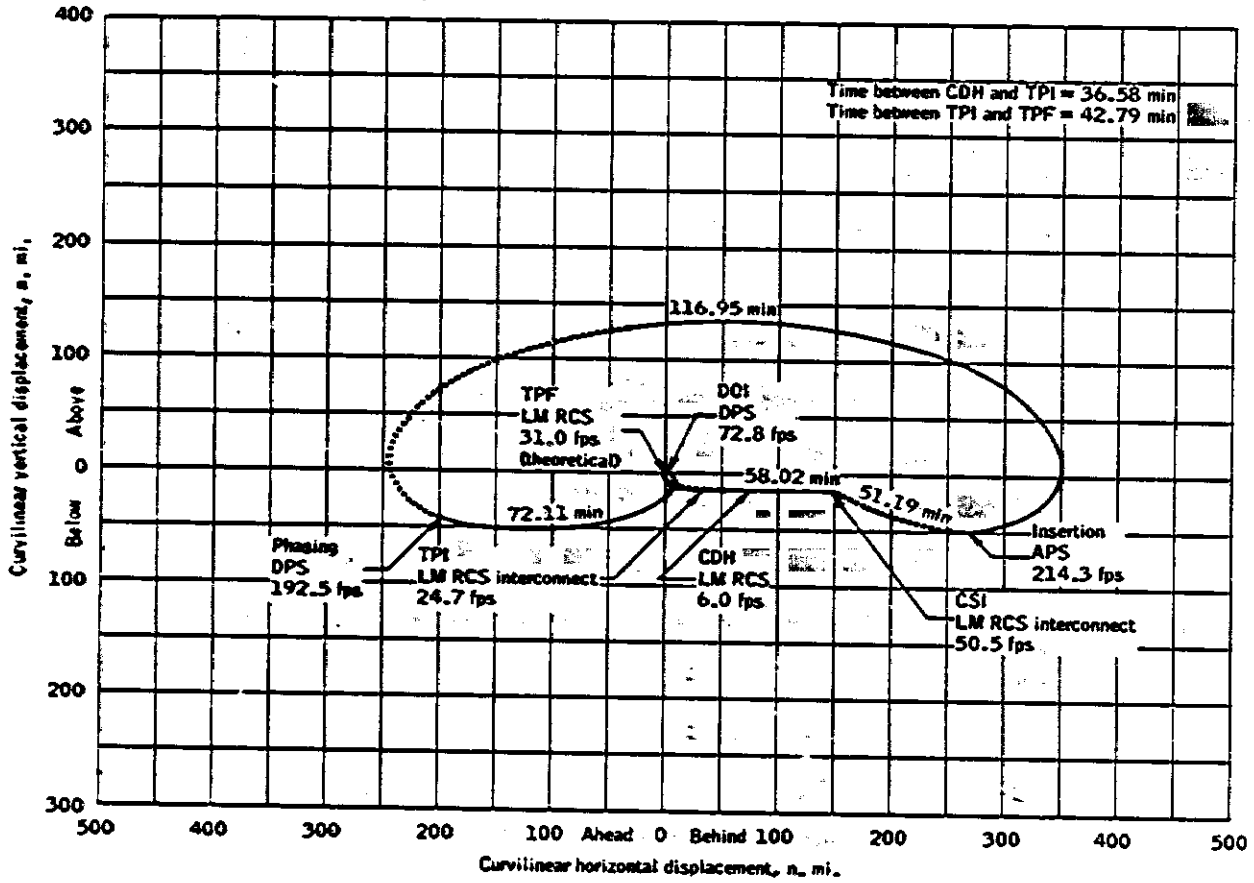
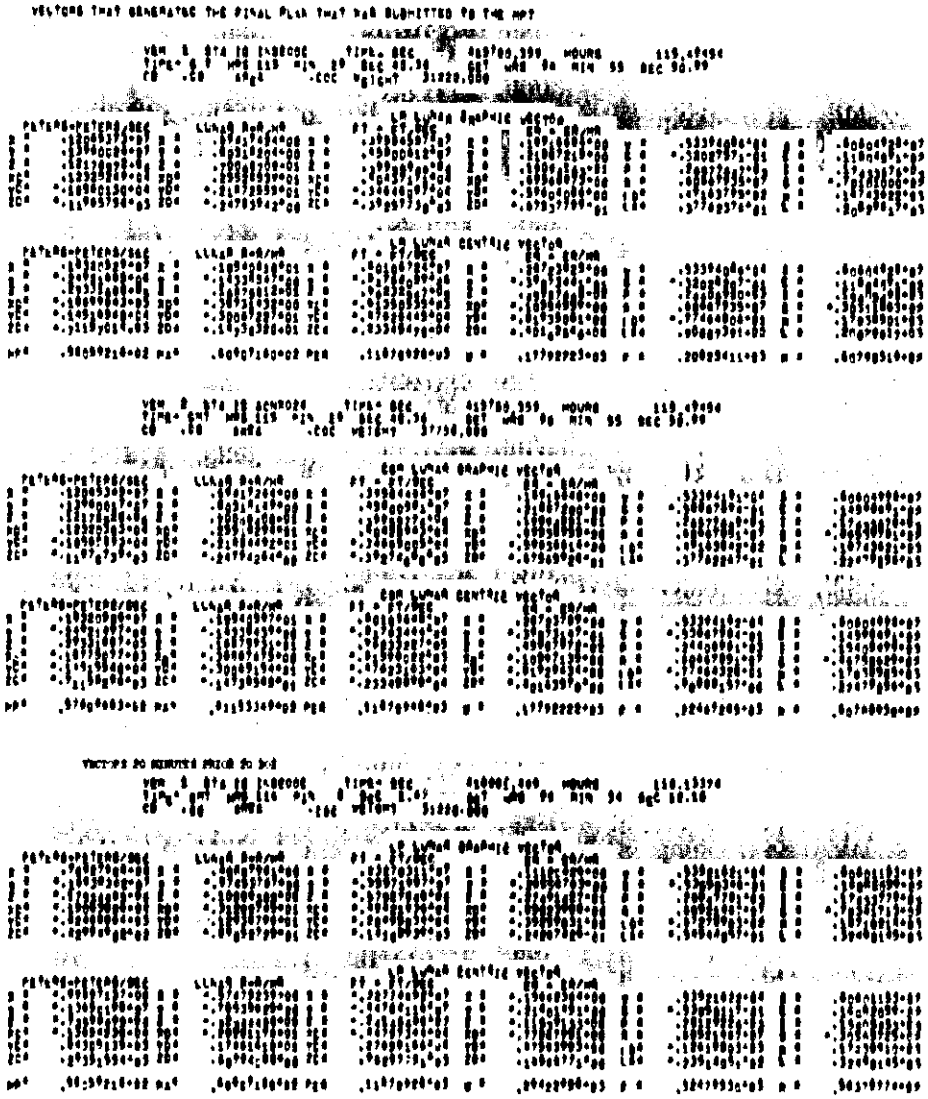


Figure 1.- Relative motion (curvilinear, CSM-centered) for nominal rendezvous.

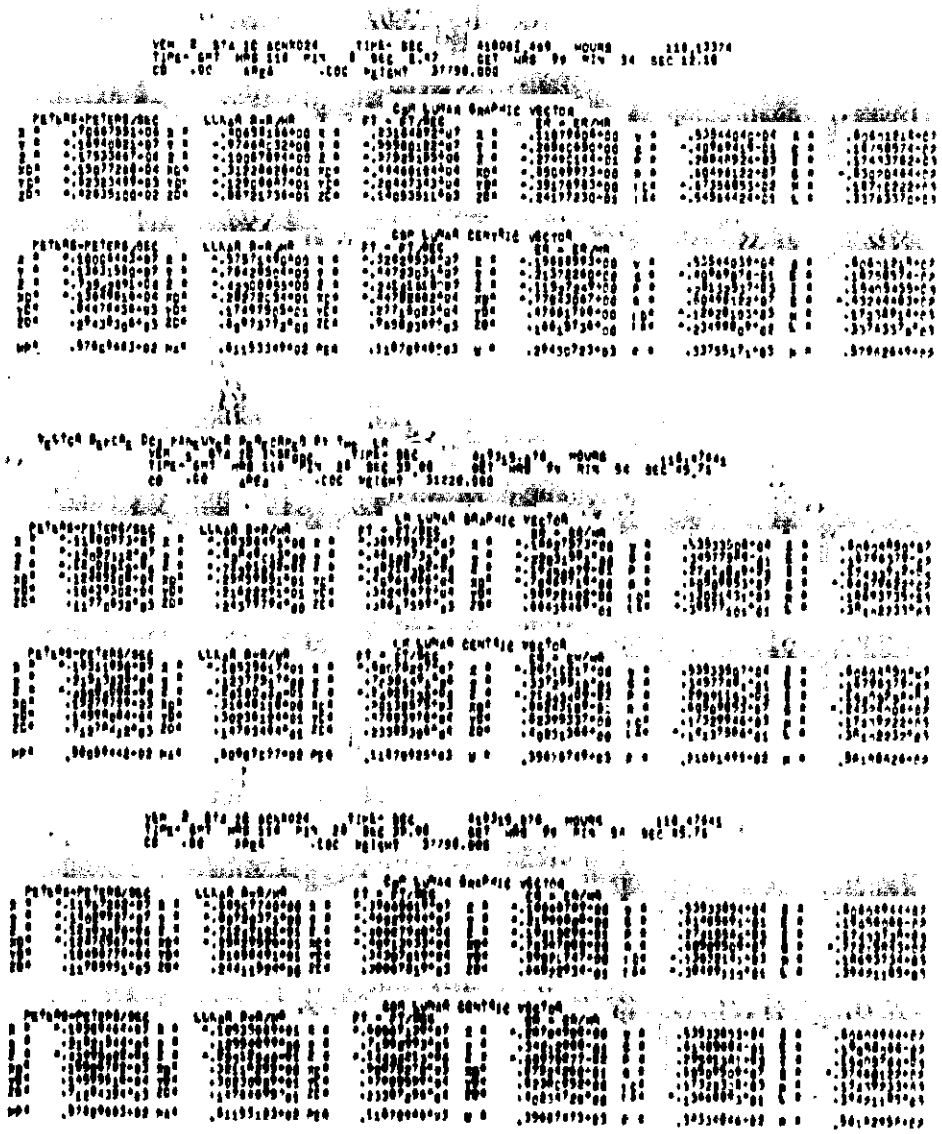
1.0 NOMINAL RENDEZVOUS PROFILE

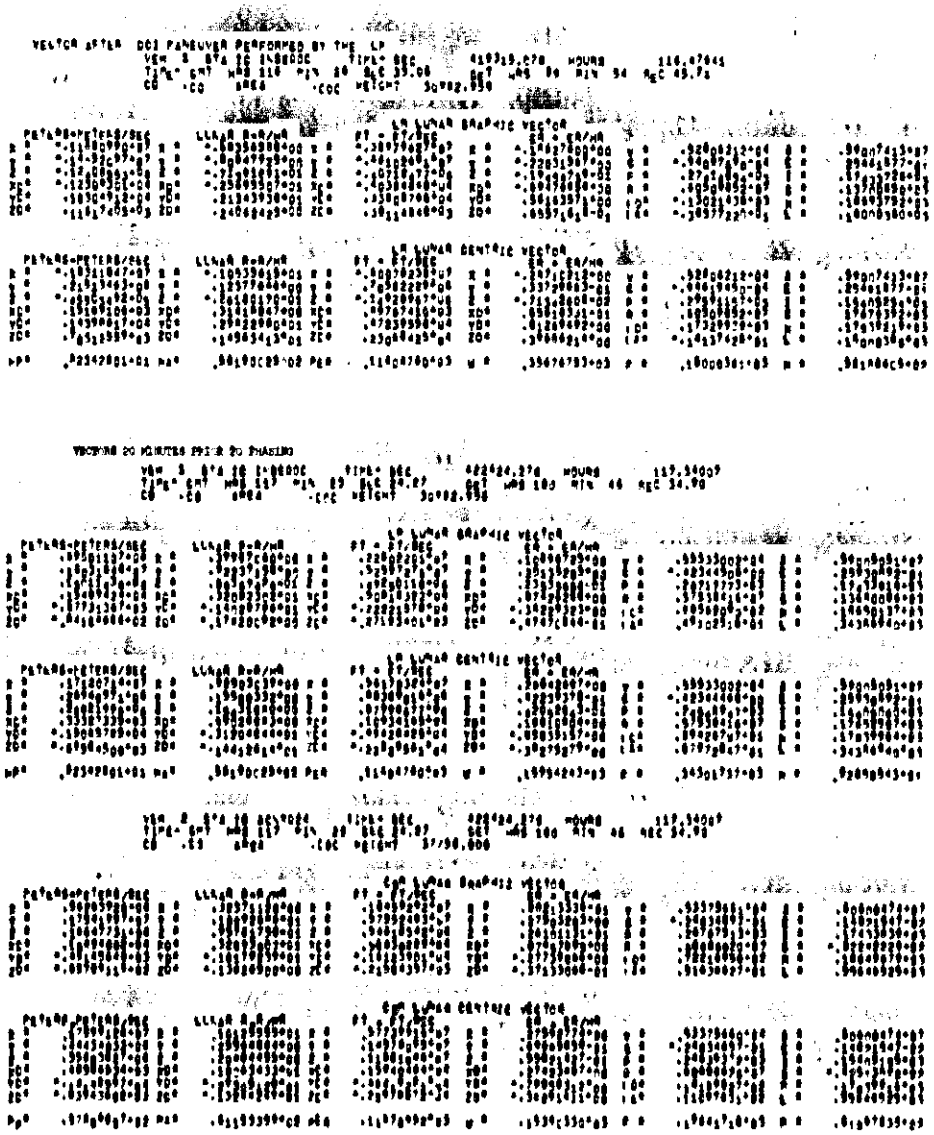
1.1 VECTORS

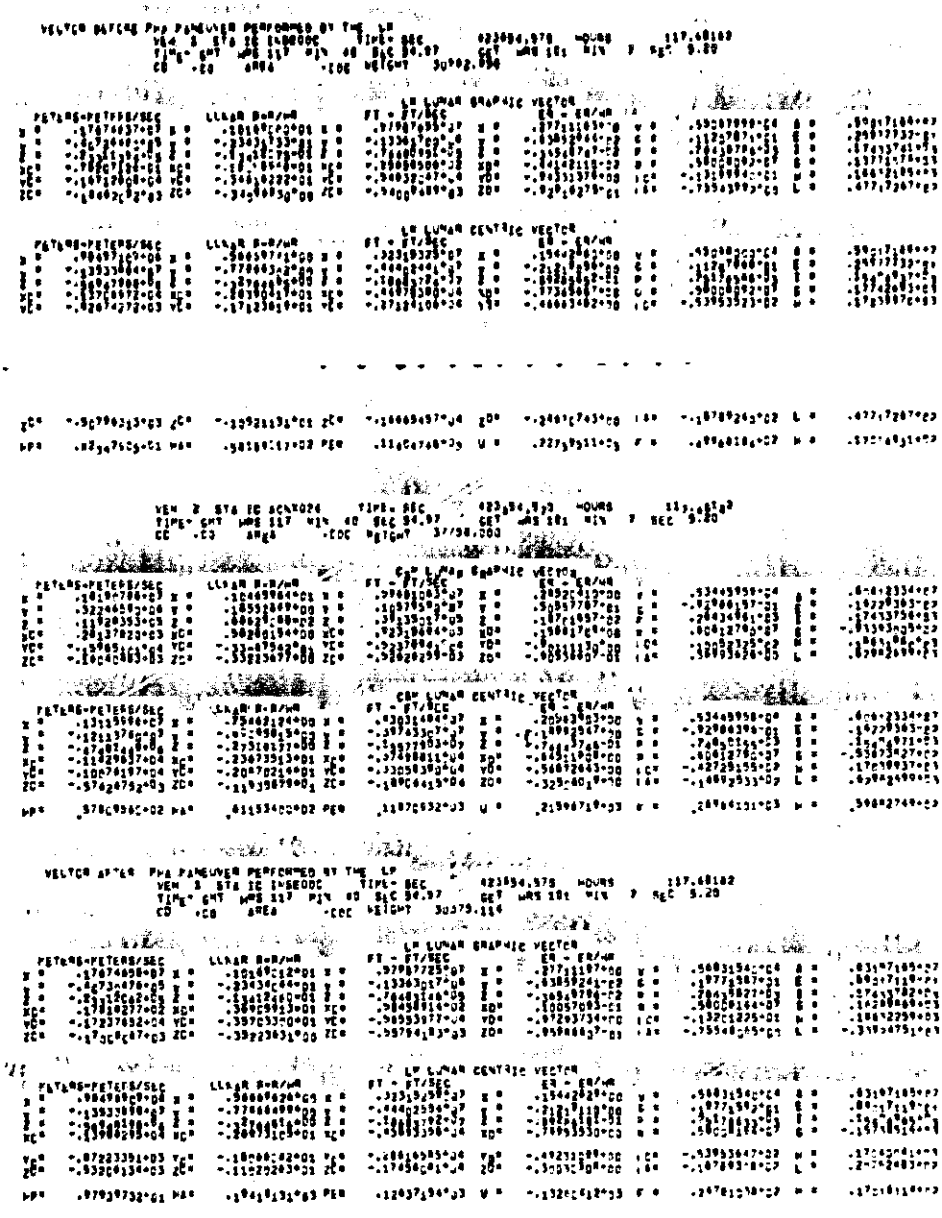
VECTORS THAT GENERATED THE FINAL PLAN THAT WAS SUBMITTED TO THE MPT

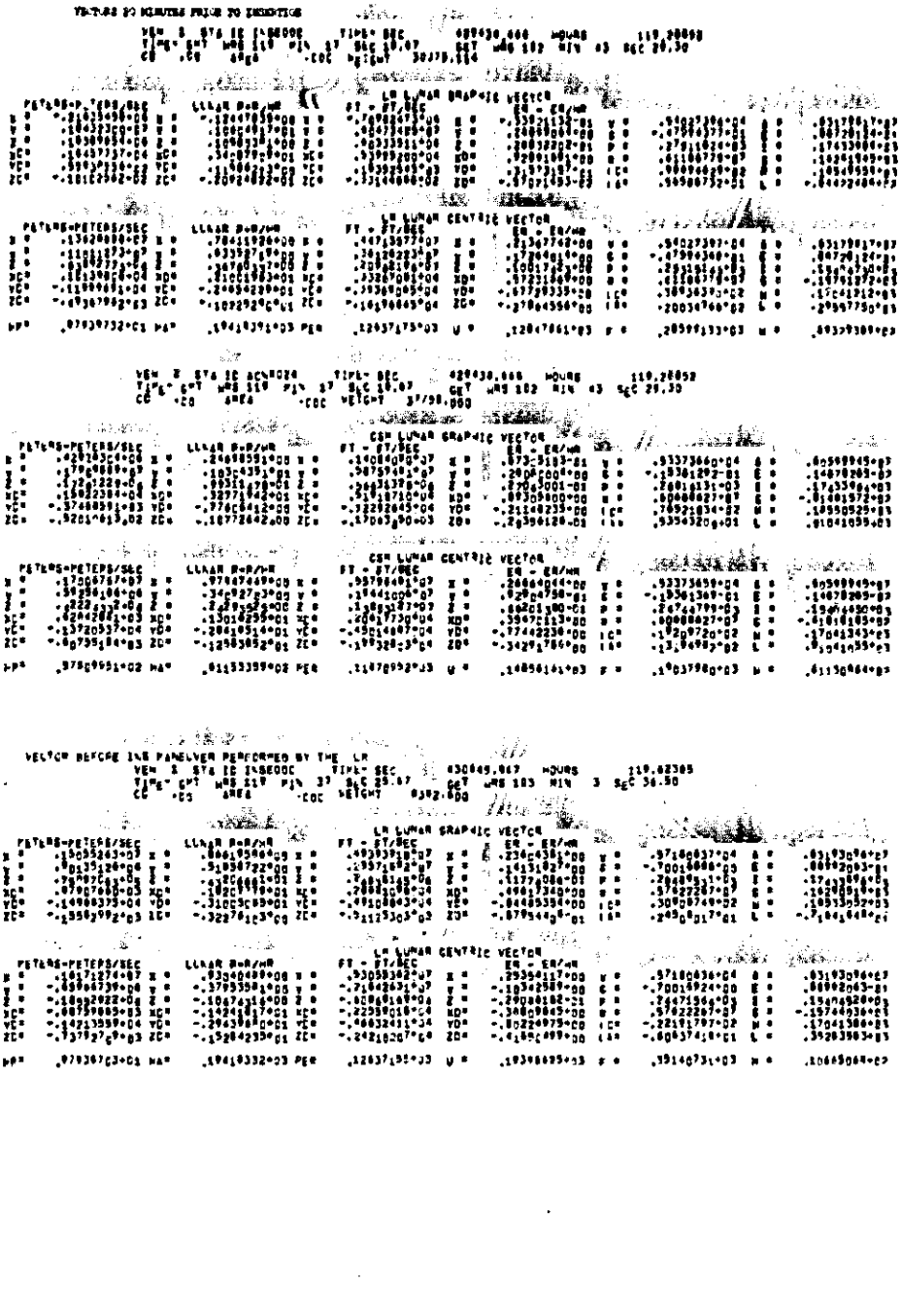


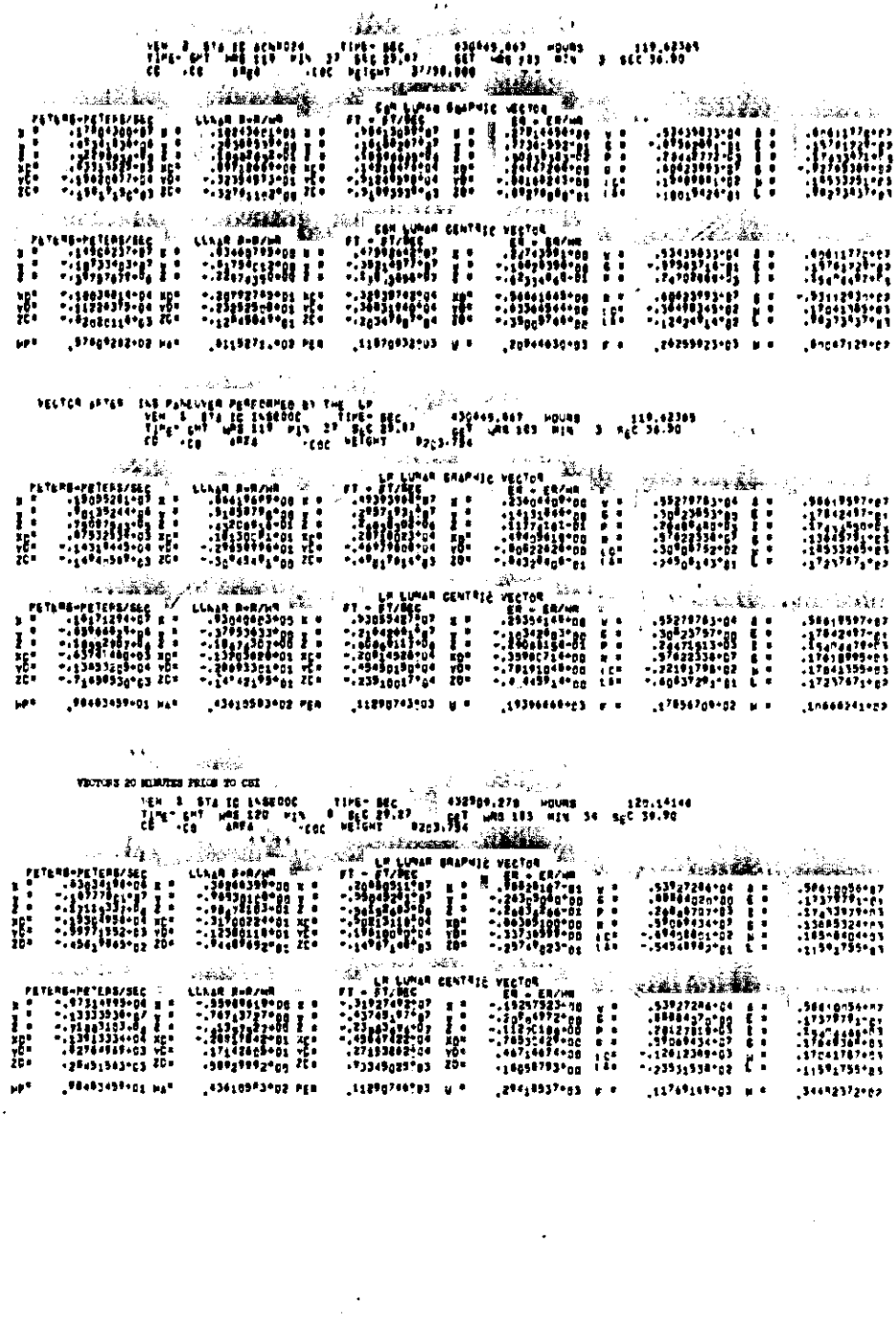
VECTORS 20 MINUTES PRIOR TO [illegible]

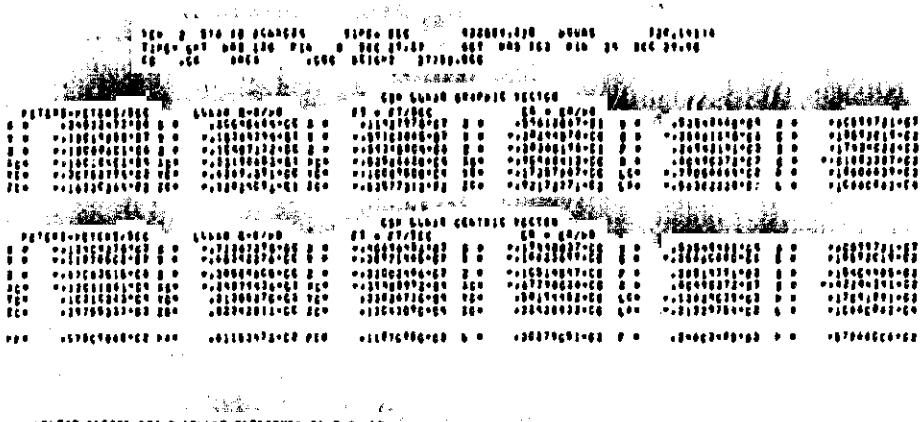


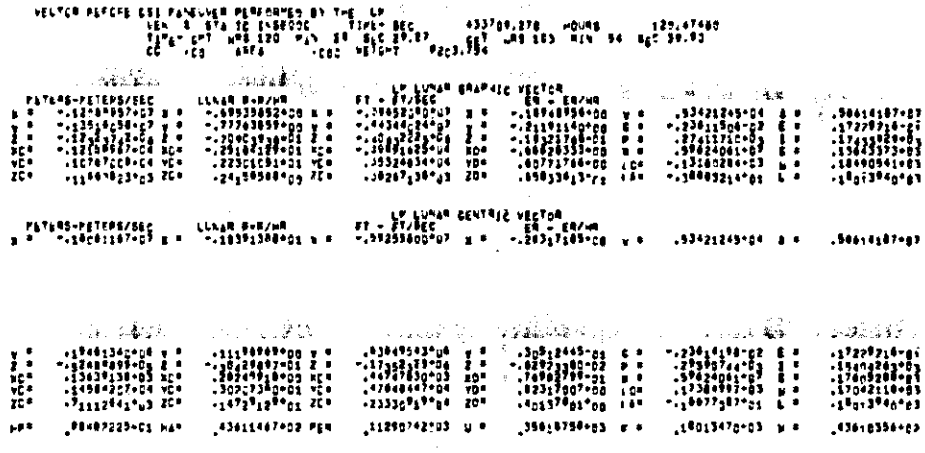


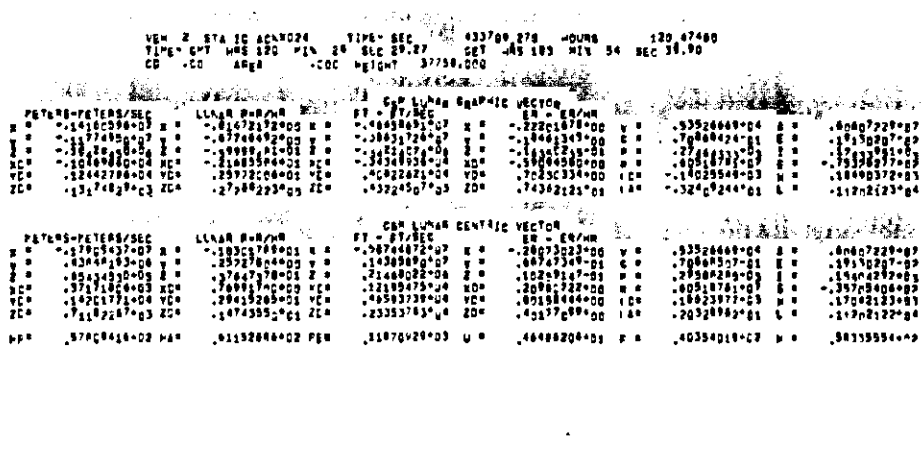


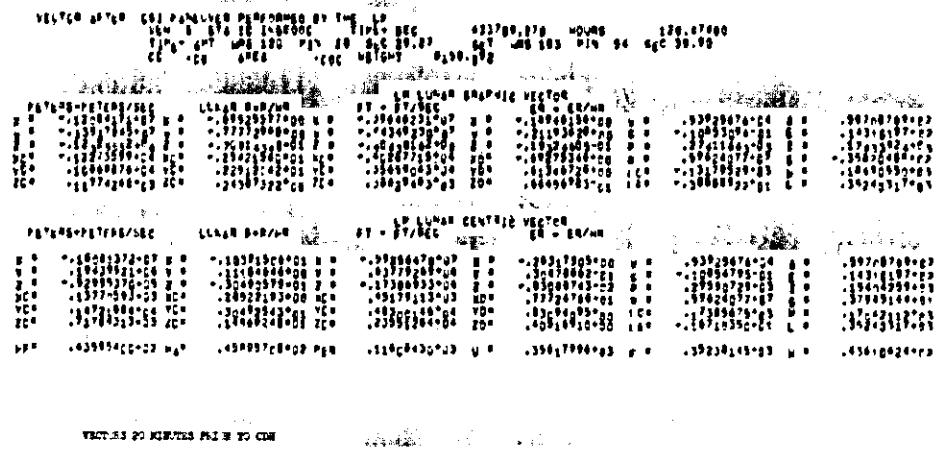


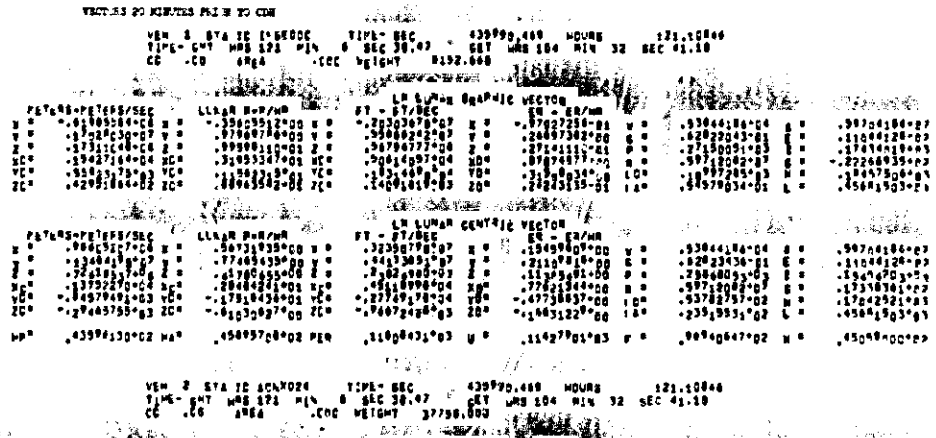


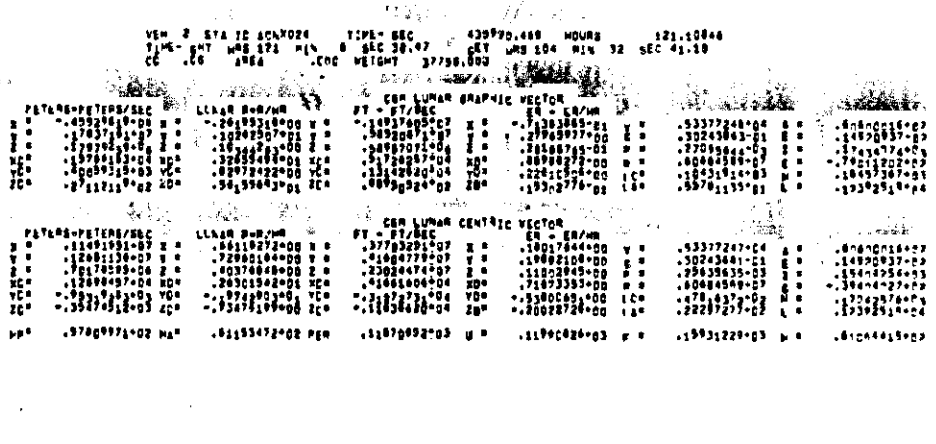


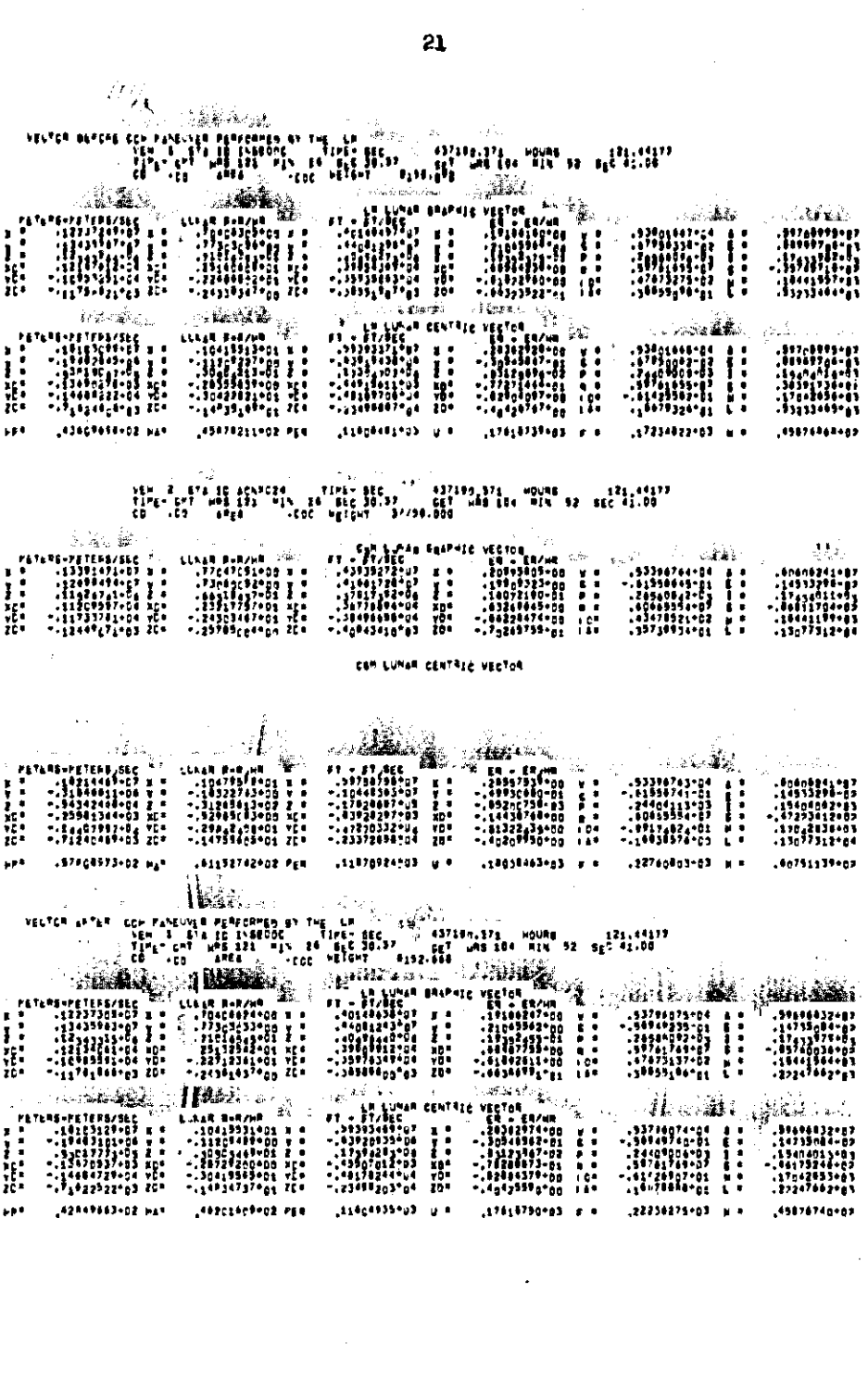


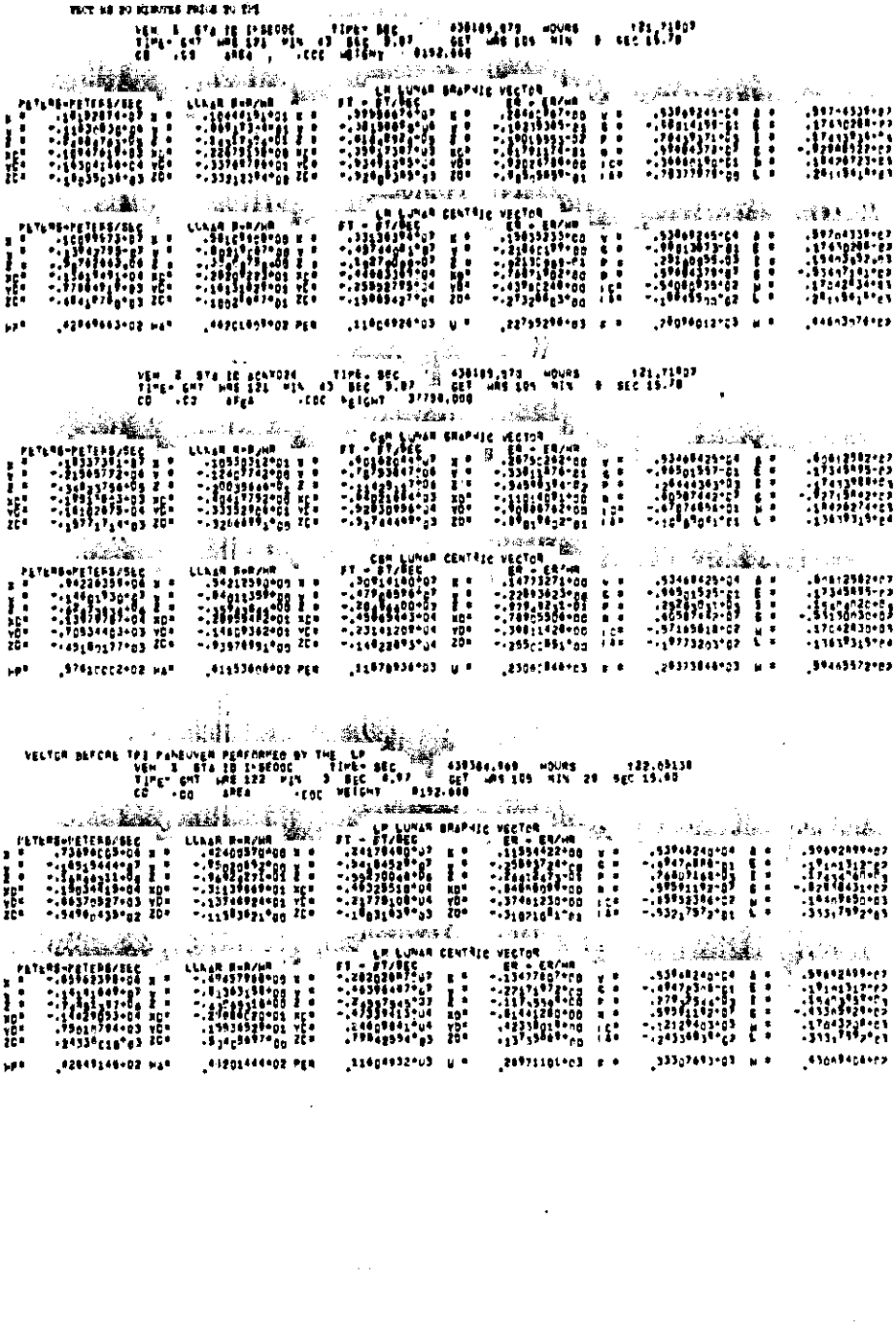


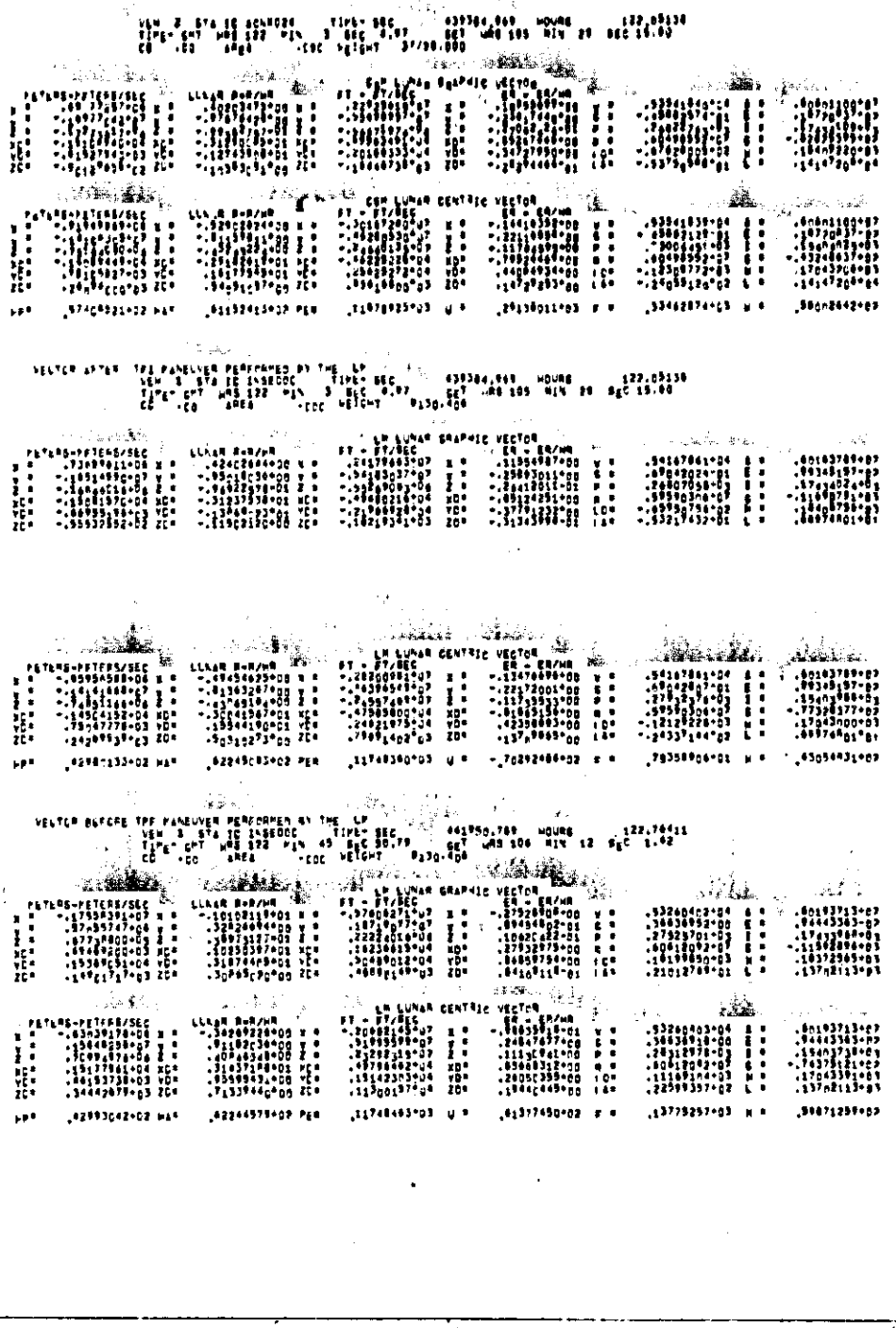


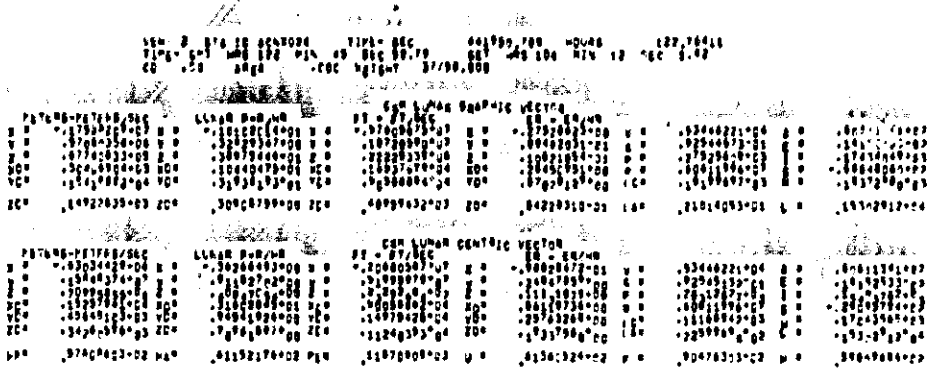


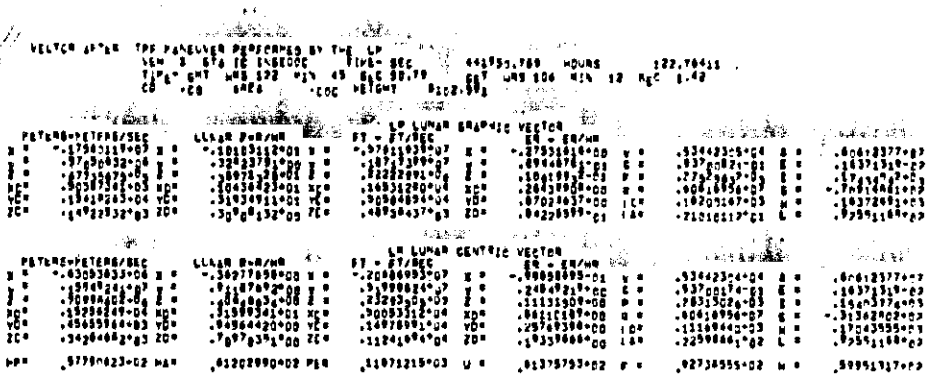


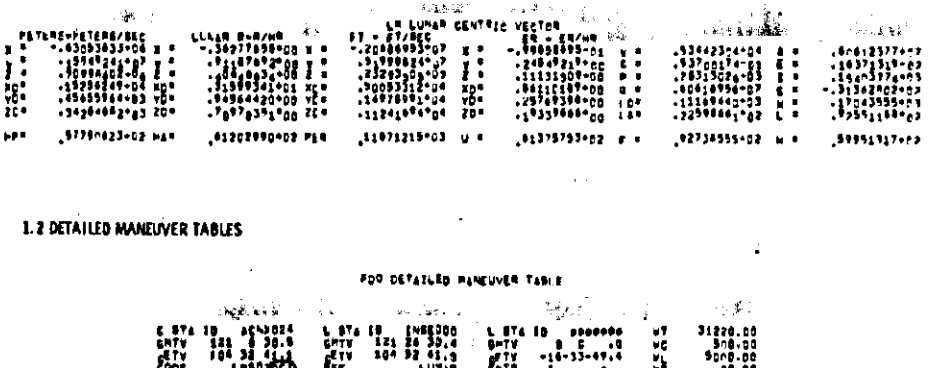












1.2 DETAILED MANEUVER TABLES

FDO DETAILED MANEUVER TABLE

C BTA ID	4C43024	L BTA ID	INBE000	L BTA ID	000000	WT	31220.00
GMTV	121 0 30.0	GMTV	121 20 30.4	GMTV	0 0 0.0	WC	300.00
GETV	104 20 41.4	GETV	104 22 41.3	GETV	-16-33-49.4	WL	9000.00
CODE	LOBO DCI	REF	LUNAR	GETR	-16-33-49.4	WP	90.00
	TTTV						
GETI	99 04 29.2	CT R	0 20.3	DT TO	6.80	REFSMMAT	DEL P 5.6
PETI	114 20 14.6	CT V	0.00	DV TO	2.23	DCFLM	DEL Y 5.7
DVM	72.8	VGX	22.1	DV	.1	VX .0	YW 180.5
DVREM	72.2	VGY	-.0	ZD	287.2	PX .0	PM -.0
DVC	72.8	VGZ	69.8	YM	359.9	RX .0	RM -180.0
VF	72.78	N B1	38.2	TA	58.178	VP	9559.55
VS	.00	P B1	3 35 8	PP	0.234	THETA P	-19.36
VD	1.01	L B1	120 18 W	L AN	173 11 W	DELTA P	.00
DH	-.01	P B1	20.24	E	.0259 6108	P LLS	2 37 N
PHASE	157			I	174.3373	L LLS	34 3 E
PHASE DOT	-14.72	L B2.7		AP	137.9009	R LLS	-.914
VERDOT ANG	.000	UNTIL					
YD	.0000	DAY					

TARGETS

PCNS			ΔGS					LAMBERT		HVR	
EXT CV	LM		EXT CV	LM							
GETI	99 34 25.2		GETI	99 34 25.2	GETI	99 34 25.2				GETI	99 34 25.2
VV	-72.7938		VX	-72.7938	V F	0 24 30.8				APSIS	0
VY	-.0015		VY	.0022	X	-.0000009.98				ELEV	.00
VZ	0 .0063		VZ	0.0038	Y	-.0004271.87				TPI	0 0 .0
					Z	-.0057894.87				DT	0 .0
					C	.000		OPTION			

LT AFTER 3'642.98

FOD DETAILED MANEUVER TABLE

C STA ID	4[illegible]024		L STA ID	INBE300		L STA ID	INBE000			VT	35[illegible]2.88
GMTV	121 0 35.5		GMTV	121 26 32.4		GMTV	0 0 .0			WC	500.00
GETV	104 32 41.1		GETV	104 52 41.0		GETV	-16-33-49.4			WL	500.00
CODE	LAE0		AEP	LUNAR		GETR	-16-33-49.4			WP	500.00
GETI	103 3 39.6		DT B	0 19.0		DT TB	.25		REFSMMAT	DEL P	0.0
PETI	119 33 17.9		DT W	0.00		DV TB	0.19		DCFLW	DEL Y	0.0
EVM	214.3		VGX	109.2		DV	105.2		TB	.0	YM -180.0
EVREF	785.7		VGY	0.1		DP	0.5		PB	.0	PM 28.2
EVC	213.1		VGZ	-100.1		HA	.3		RB	.0	RM -.0
VF	-100.93		N BI	10.0		4A	43.011		VP	9532.69	
VS	-.25		P BI	2 29 N		4P	0.048		THETA P	-14.00	
VD	-101.13		L BI	31 22 E		ΔH	175.13 M		DELTA P	.00	
DH	49.98		F BI	-9.05		X	.0170429[illegible]		P LLS	2 37 N	
PHASE	17.470					Y	174.3395		L LLS	34 3 E	
PHASE DOT	-18.30		0 39.8			VP	136.4579		R LLS	-.8,8	
HEDGE ANG	.012		UNTIL								
VD	.0069		EARTH								

TARGETS

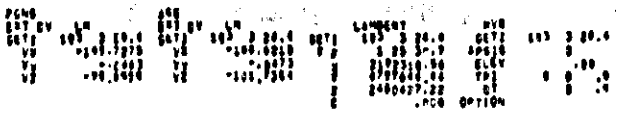
PCNS			ΔGS					LAMBERT		HVR	
EXT CV	LM		EXT CV	LM							
GETI	101 0 31.7		GETI	101 0 31.7	GETI	101 0 31.7				GETI	101 0 31.7
VV	173.2020		VX	174.4925	V F	0 39 21.3				APSIS	0
VY	.0648		VY	.0461	X	4[illegible]993[illegible]6.75				ELEV	.00
VZ	-84.5708		VZ	-81.5435	Y	3[illegible]5[illegible]7.28				TPI	0 0 .0
					Z	1[illegible]11[illegible]:38				DT	0 .0
					C	.108		OPTION			

LT AFTER 30279.11

FOD DETAILED MANEUVER TABLE

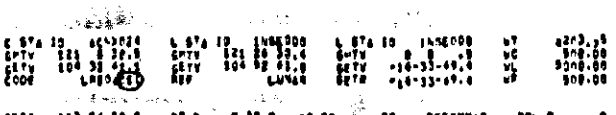
C STA ID	4[illegible]024		L STA ID	INBE300		L STA ID	INBE000			VT	35[illegible]2.88
GMTV	121 0 35.5		GMTV	121 26 32.4		GMTV	0 0 .0			WC	500.00
GETV	104 32 41.1		GETV	104 52 41.0		GETV	-16-33-49.4			WL	500.00
CODE	LAE0		AEP	LUNAR		GETR	-16-33-49.4			WP	500.00
GETI	103 3 39.6		DT B	0 19.0		DT TB	.25		REFSMMAT	DEL P	0.0
PETI	119 33 17.9		DT W	0.00		DV TB	0.19		DCFLW	DEL Y	0.0
EVM	214.3		VGX	109.2		DV	105.2		TB	.0	YM -180.0
EVREF	785.7		VGY	0.1		DP	0.5		PB	.0	PM 28.2
EVC	213.1		VGZ	-100.1		HA	.3		RB	.0	RM -.0
VF	-100.93		N BI	10.0		4A	43.011		VP	9532.69	
VS	-.25		P BI	2 29 N		4P	0.048		THETA P	-14.00	
VD	-101.13		L BI	31 22 E		ΔH	175.13 M		DELTA P	.00	
DH	49.98		F BI	-9.05		X	.0170429[illegible]		P LLS	2 37 N	
PHASE	17.470					Y	174.3395		L LLS	34 3 E	
PHASE DOT	-18.30		0 39.8			VP	136.4579		R LLS	-.8,8	
HEDGE ANG	.012		UNTIL								
VD	.0069		EARTH								

TARGETS

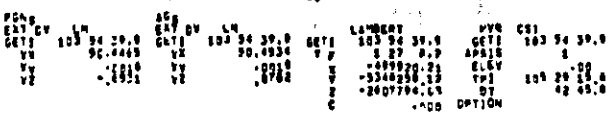


LT AFTER 82d3.75

PDO DETAILED MANEUVER TABLE

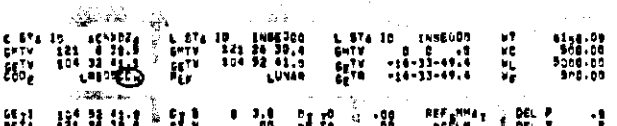


TARGETS

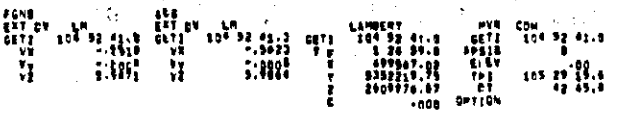


LT AFTER 8150.69

PDO DETAILED MANEUVER TABLE



TARGETS

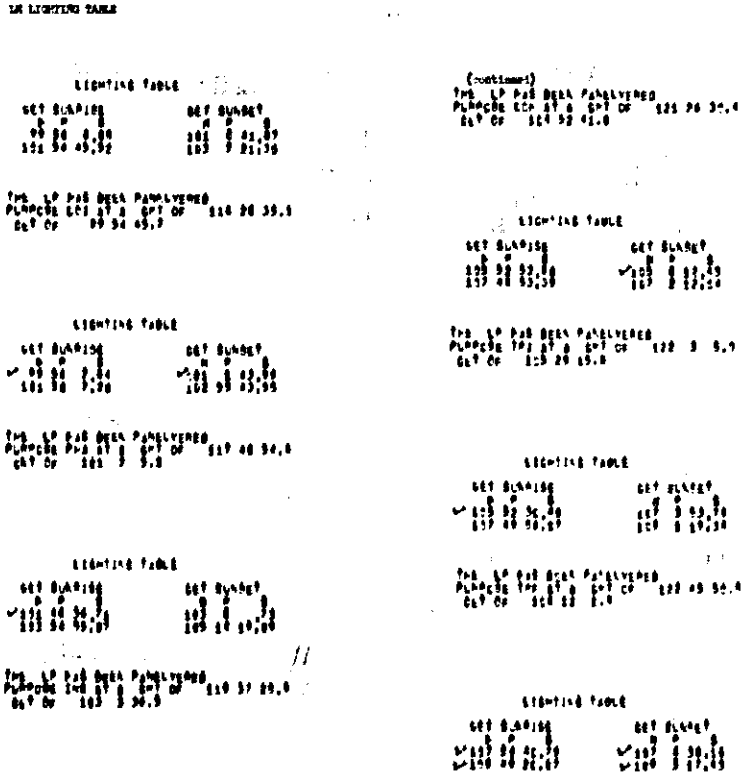


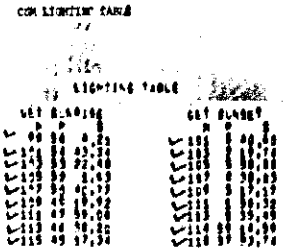
LT AFTER 8192.67

FDO DETAILED MANEUVER TABLE

| | | |

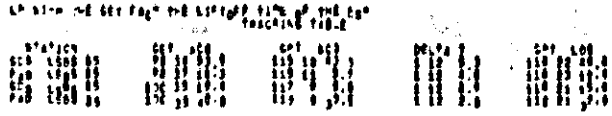
1.3 SUNRISE-SUNSET TABLES

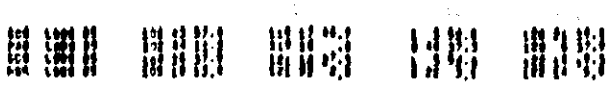


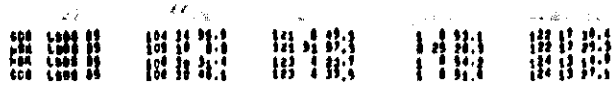


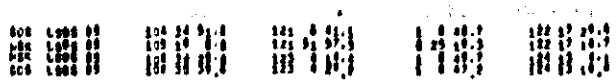
LIGHTING TABLE

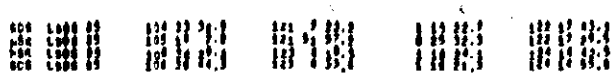
8.4 MSFN DEEP-SPACE TRACKING

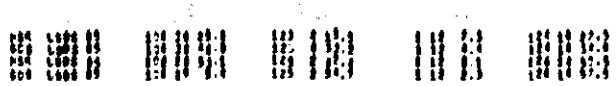


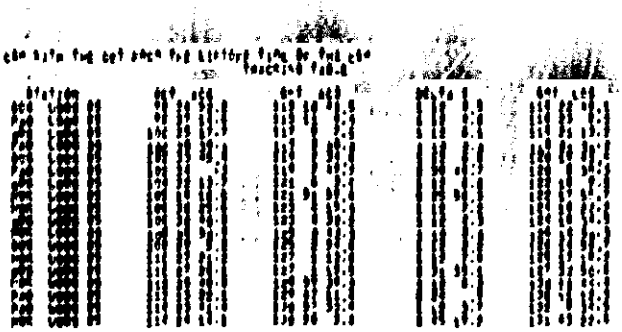












2.0 RESCUE AFTER A PARTIAL DOI MANEUVER OF 20 FPS

TABLE II.- SUMMARY OF THE SEQUENCE OF EVENTS FOR A RESCUE AFTER A PARTIAL DOI MANEUVER OF 20 FPS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	DOI	DPS (40%)	--
CSM	Rescue initiation (H)[b]	SPS	1
CSM	CSI (C1)[b]	SPS or SM RCS	1/2
CSM	CDH (SR)[b]	SPS or SM RCS	1[c]
CSM	TPI	SPS or SM RCS	1/4
CSM	TPF	SM RCS	1/3

[a]CSM rendezvous with a coelliptic Δh of 10 n. mi. above the LM and TPI at the nominal time.

[b]The printout maneuver terminology is given in parentheses.

[c]If the ΔV obtained from the DOI maneuver is greater than approximately 25 fps, two revolutions are required between CSI and CDH, and TPI will occur one revolution later than nominally planned.

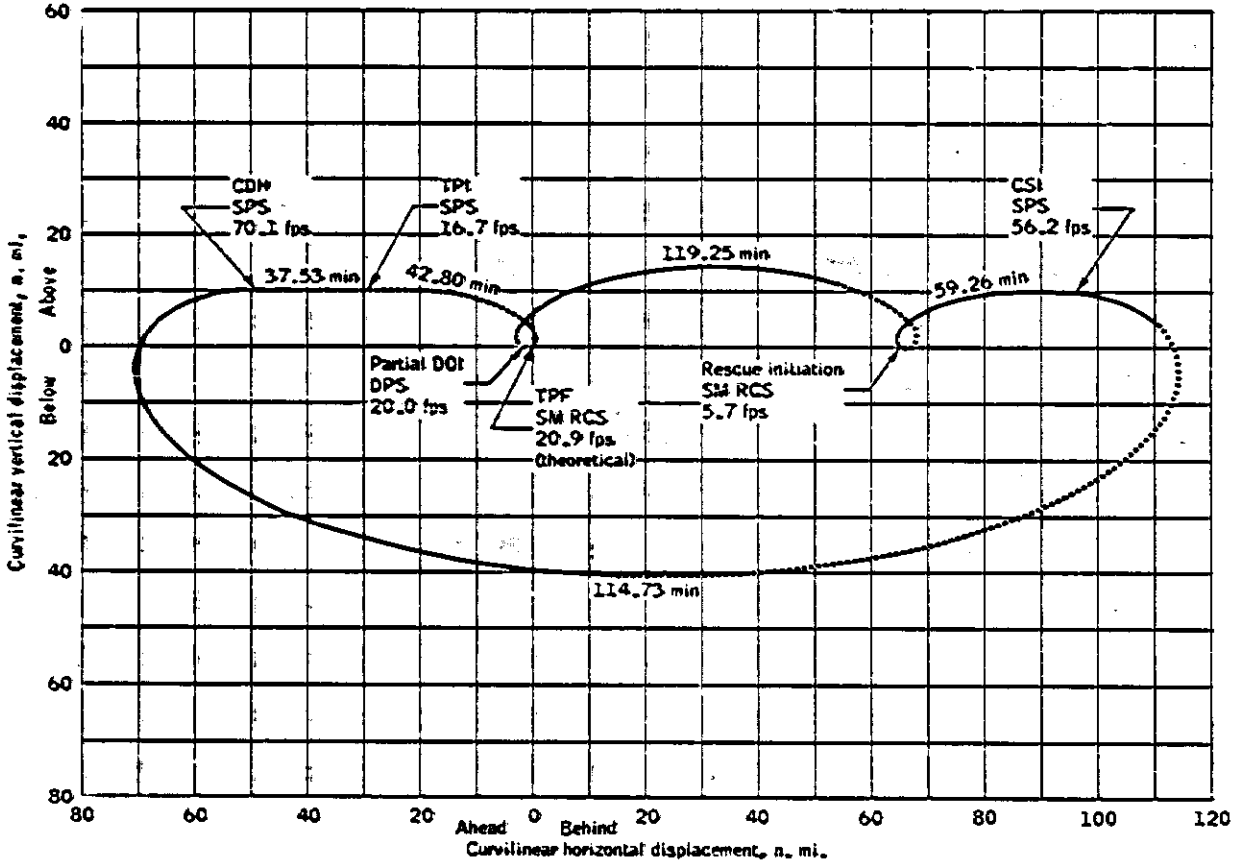
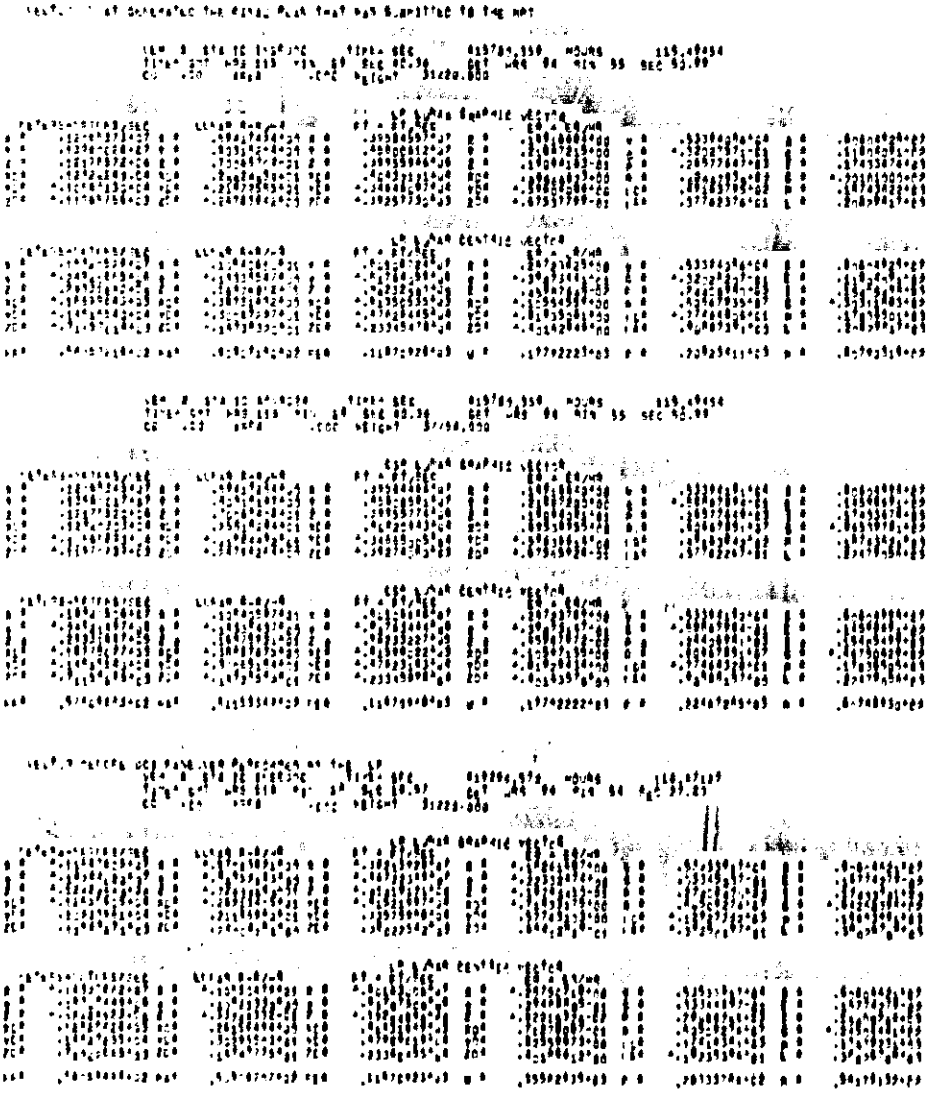
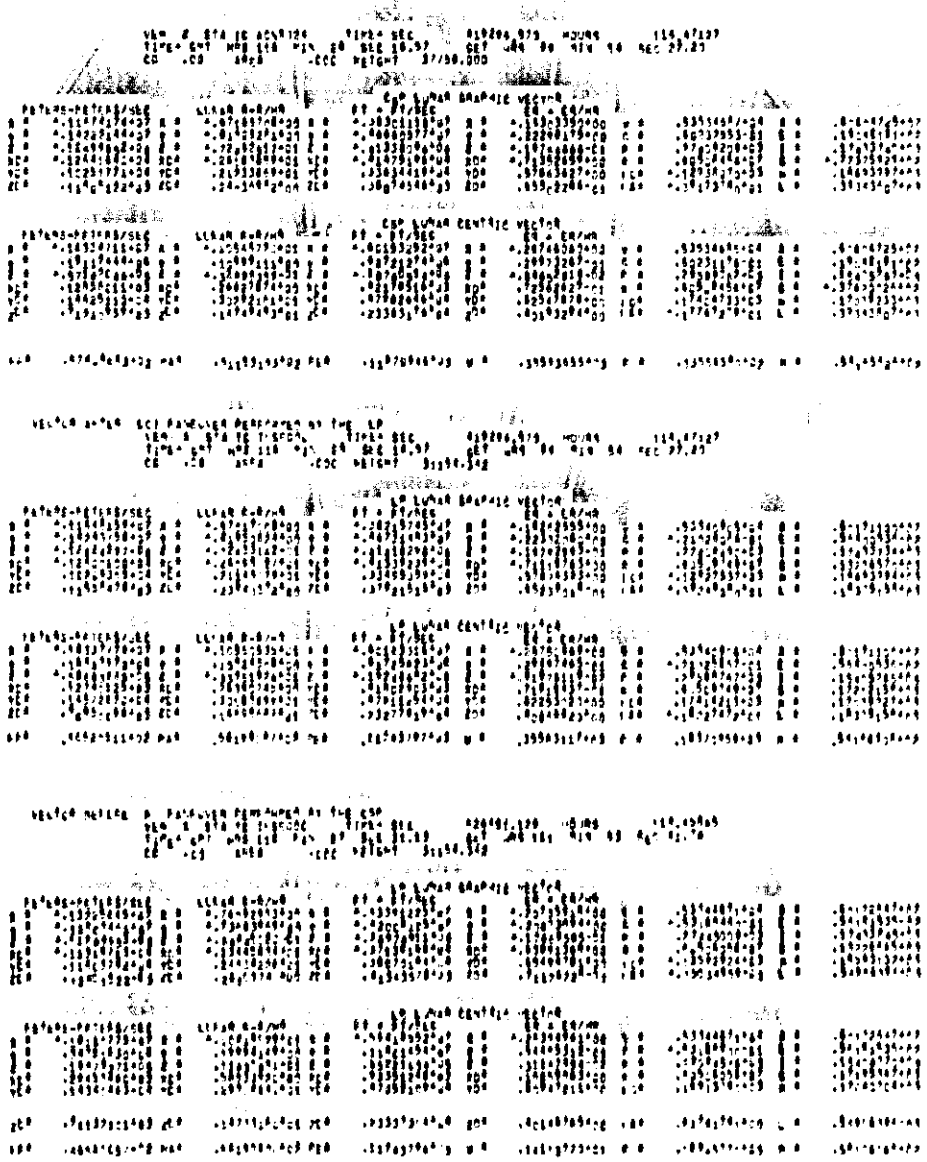


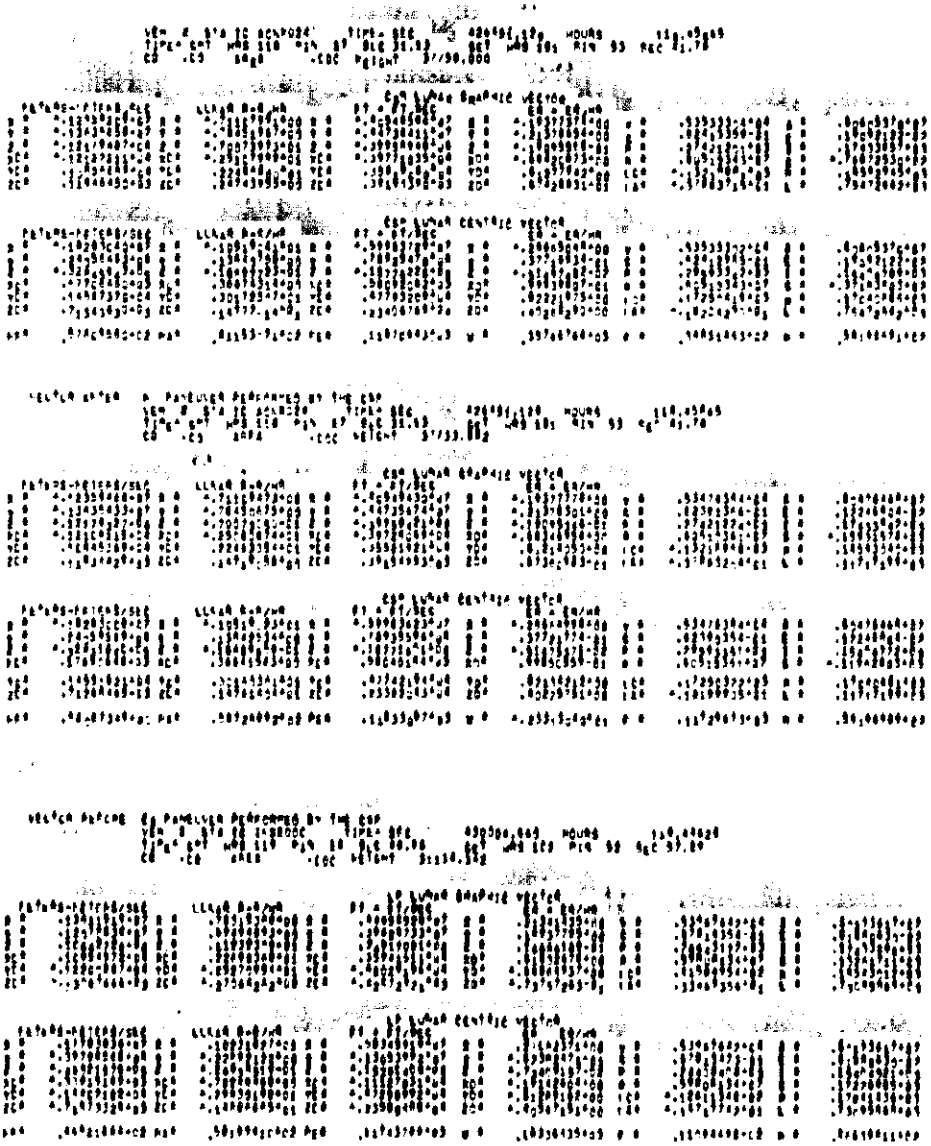
Figure 2.- Relative motion (curvilinear, LM-centered) for rescue after partial DOI of 20 fps.

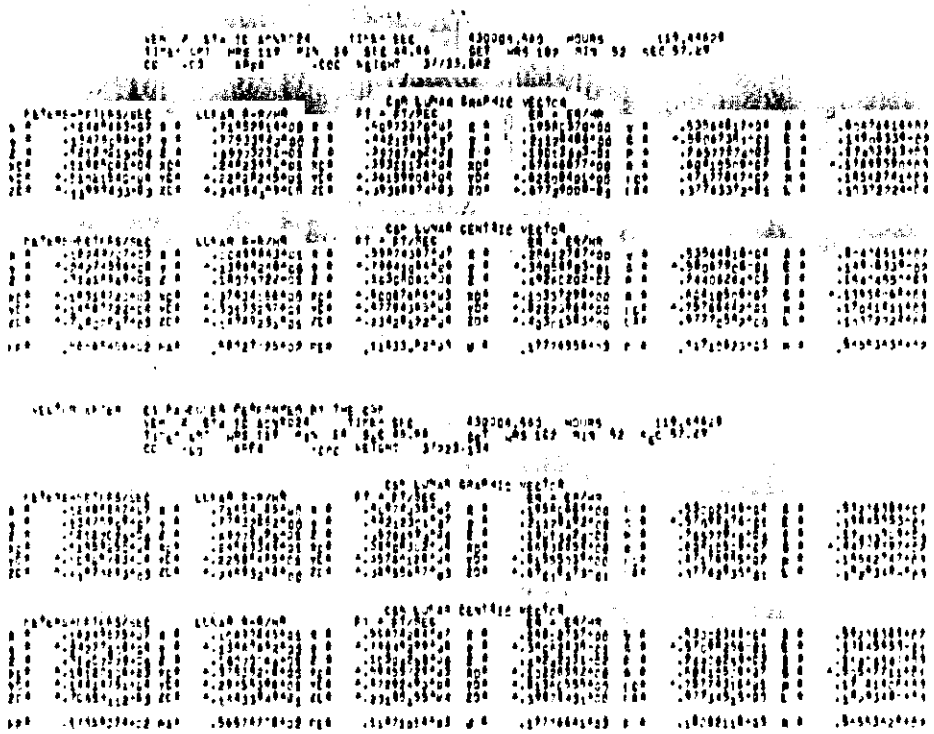
2.0 RESCUE AFTER A PARTIAL DOI MANEUVER OF 20 FPS

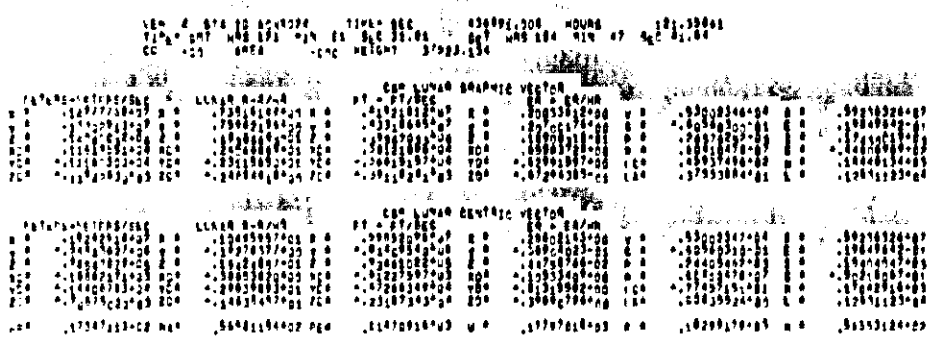
2.1 VECTORS

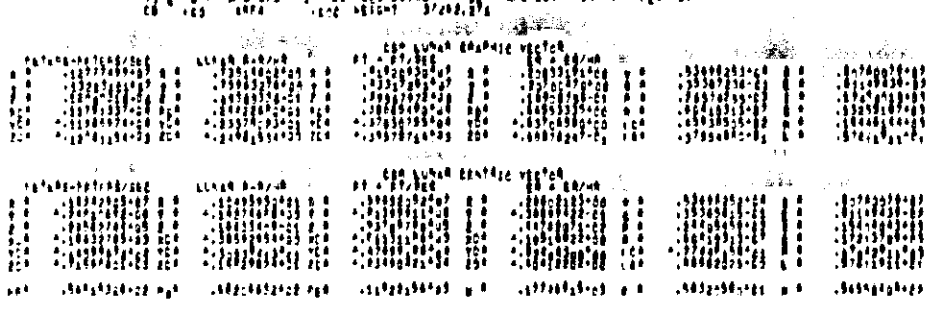


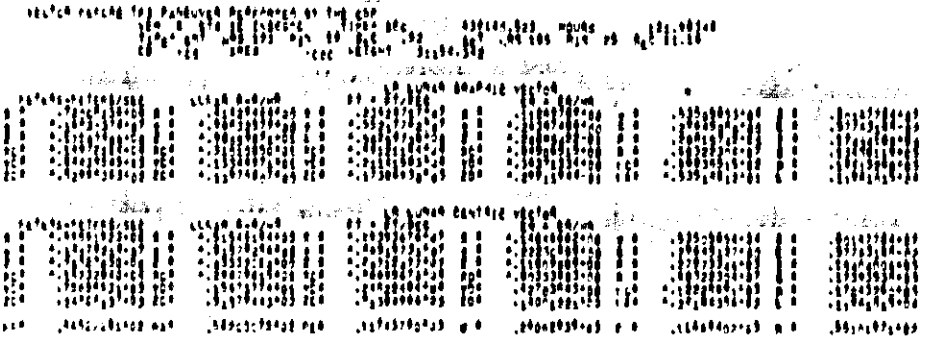


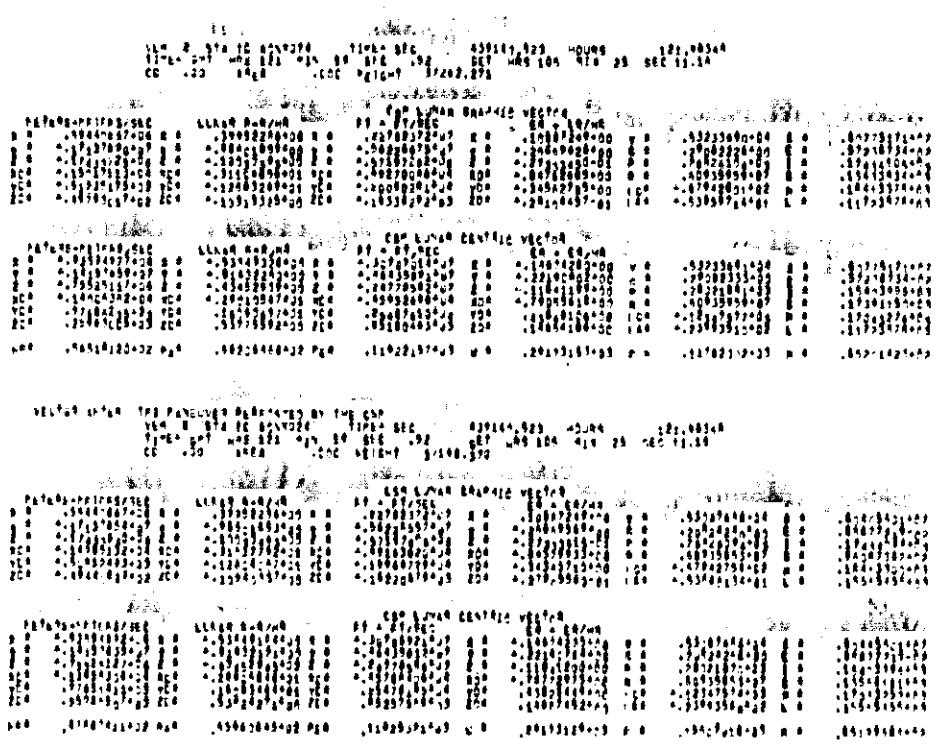


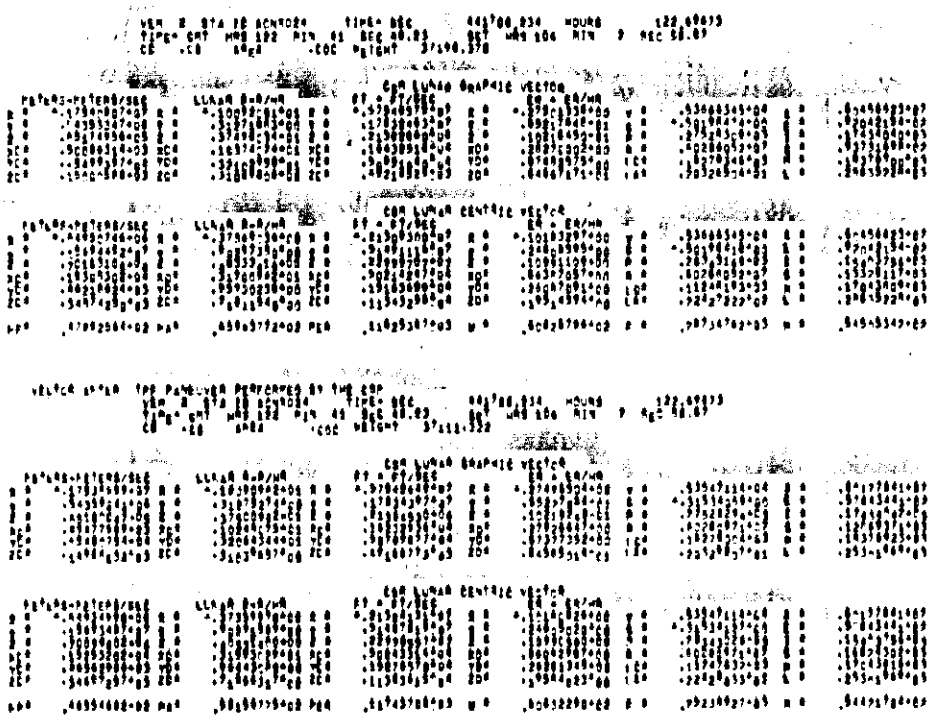




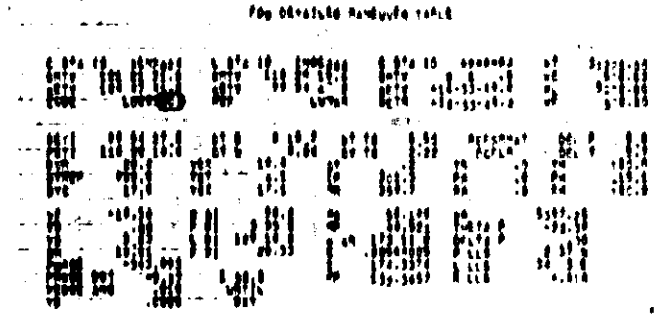




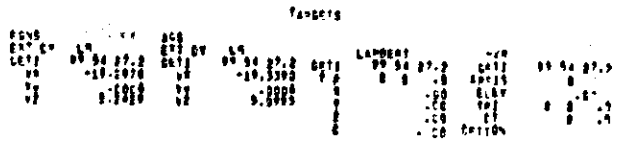


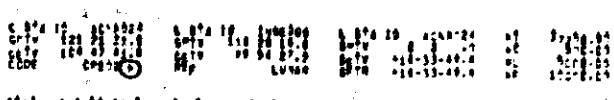


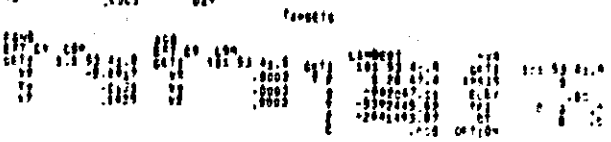
2.2 DETAILED MANEUVER TABLES

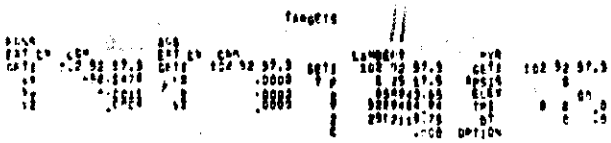


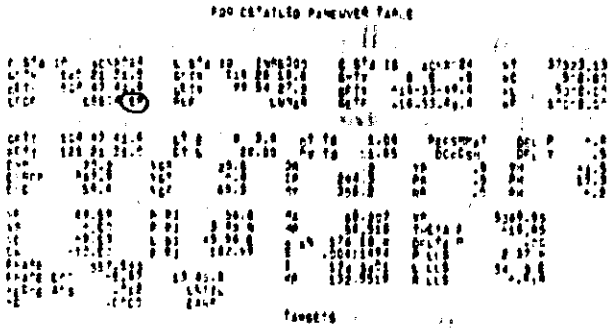
UNCLASS

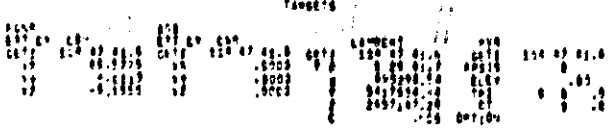


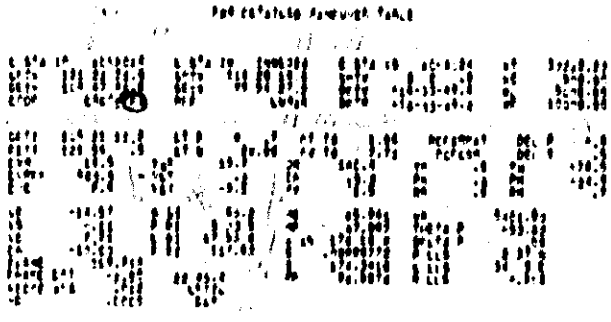


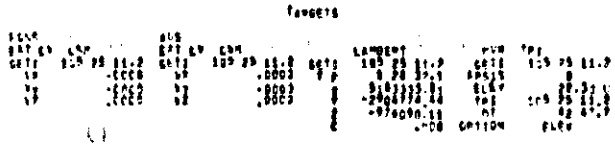


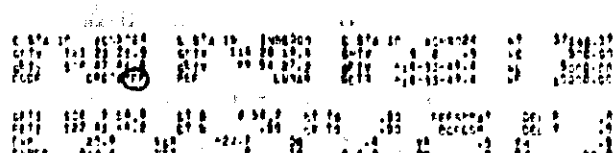


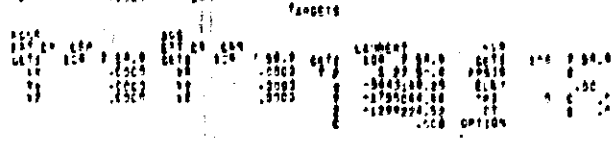




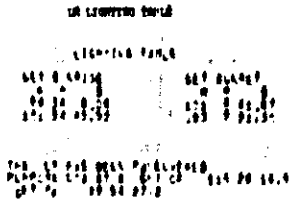


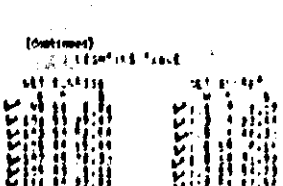






2.3 SUNRISE-SUNSET TABLES





CRM LIGHTING TABLE

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	38	0.01	18	0	42.55
6	34	42.54	18	7	17.76
6	35	22.04	17	5	48.04

THE CRM HAS BEEN DELIVERED
PLANNING AT 07:0 OFF OF 110 07 31.1
OFF AT 111 53 41.0

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	24	42.54	18	0	52.57
6	39	46.01	17	5	0.01

THE CRM HAS BEEN DELIVERED
PLANNING AT 07:0 OFF OF 110 20 46.7
OFF AT 110 52 57.3

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	33	47.03	18	0	30.01
6	41	26.50	17	0	57.78

THE CRM HAS BEEN DELIVERED
PLANNING AT 07:0 OFF OF 111 31 31.1
OFF AT 110 07 01.0

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	47	02.54	18	0	30.02
6	48	52.54	17	5	58.01

THE CRM HAS BEEN DELIVERED
PLANNING AT 07:0 OFF OF 110 00 .5
OFF AT 110 05 17.0

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	53	50.04	18	13	30.03
6	54	9.04	18	13	0.04

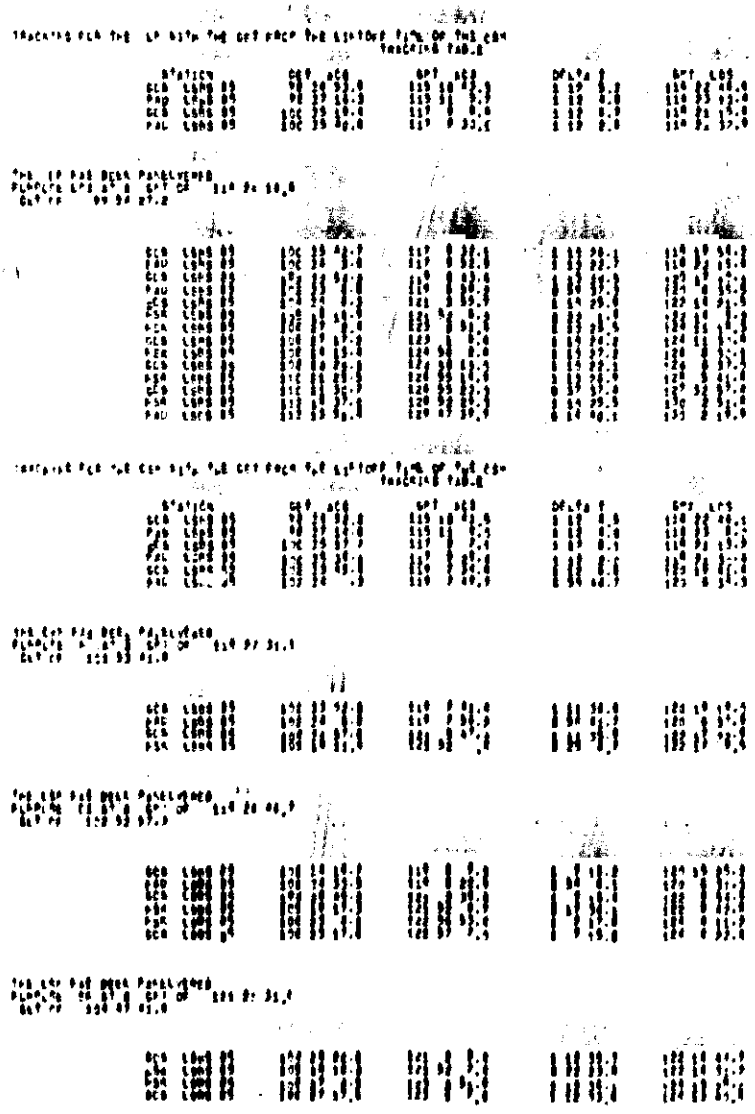
THE CRM HAS BEEN DELIVERED
PLANNING AT 07:0 OFF OF 100 01 44.0
OFF AT 110 1 50.0

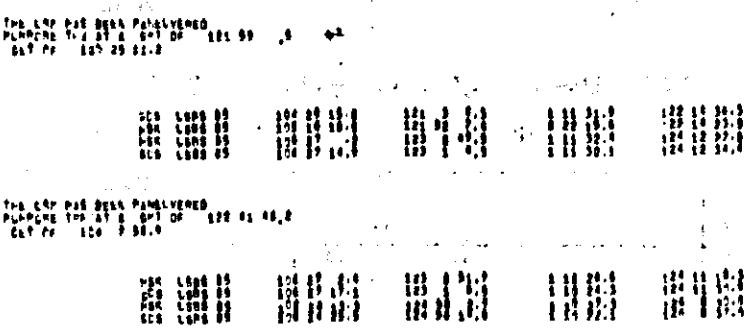
(Continued)

LIGHTING TABLE

OFF SUNRISE			OFF SUNSET		
H	M	S	H	M	S
6	43	50.55	18	0	0.01
6	43	9.11	17	5	32.19

2.4 MSFN DEEP-SPACE TRACKING





3.0 PDI ABORT AFTER A NOMINAL DOI MANEUVER

TABLE III.- SUMMARY OF THE SEQUENCE OF EVENTS FOR A PDI ABORT INITIATED AFTER A NOMINAL DOI MANEUVER[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	DOI	DPS (40%)	--
LM	Abort initiation (C1)[b]	DPS (40%)	1/2
LM	CSI (H)[b]	APS	1/2
LM	CDH (SR)[b]	APS	1/2
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI one revolution earlier than nominal time.

[b]The printout maneuver terminology is given in parentheses.

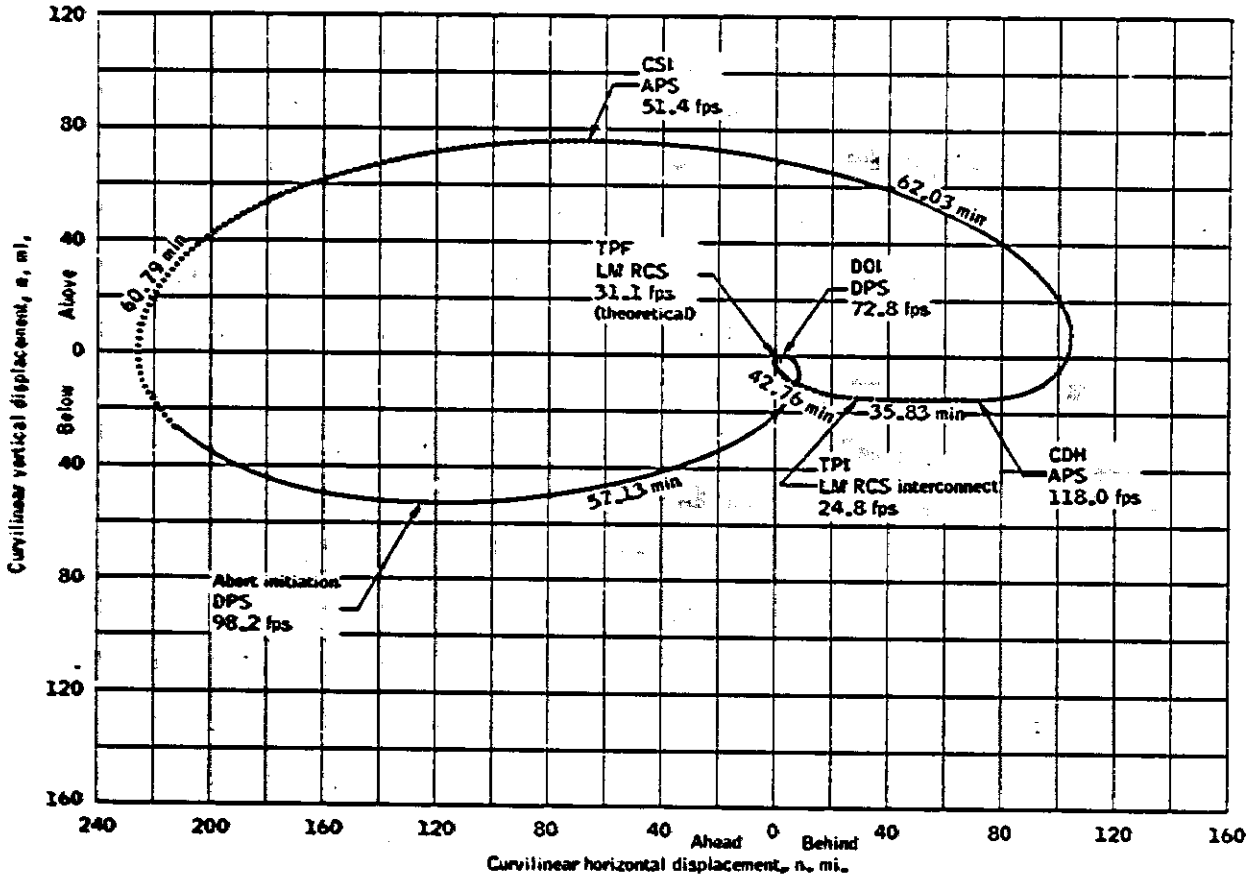
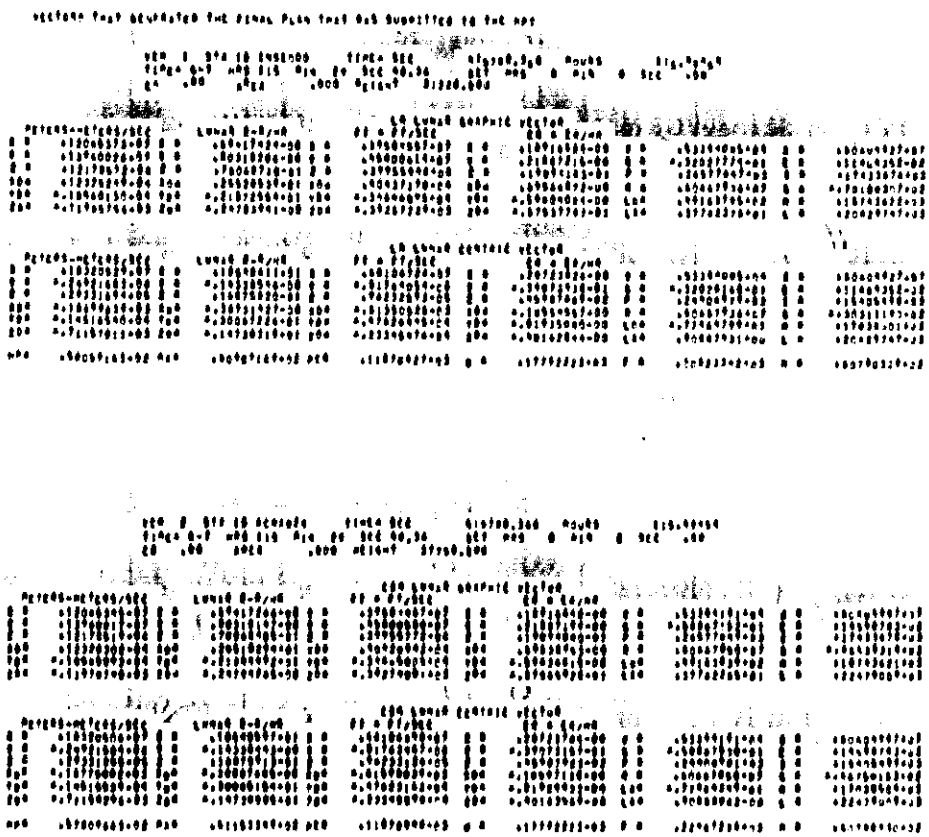
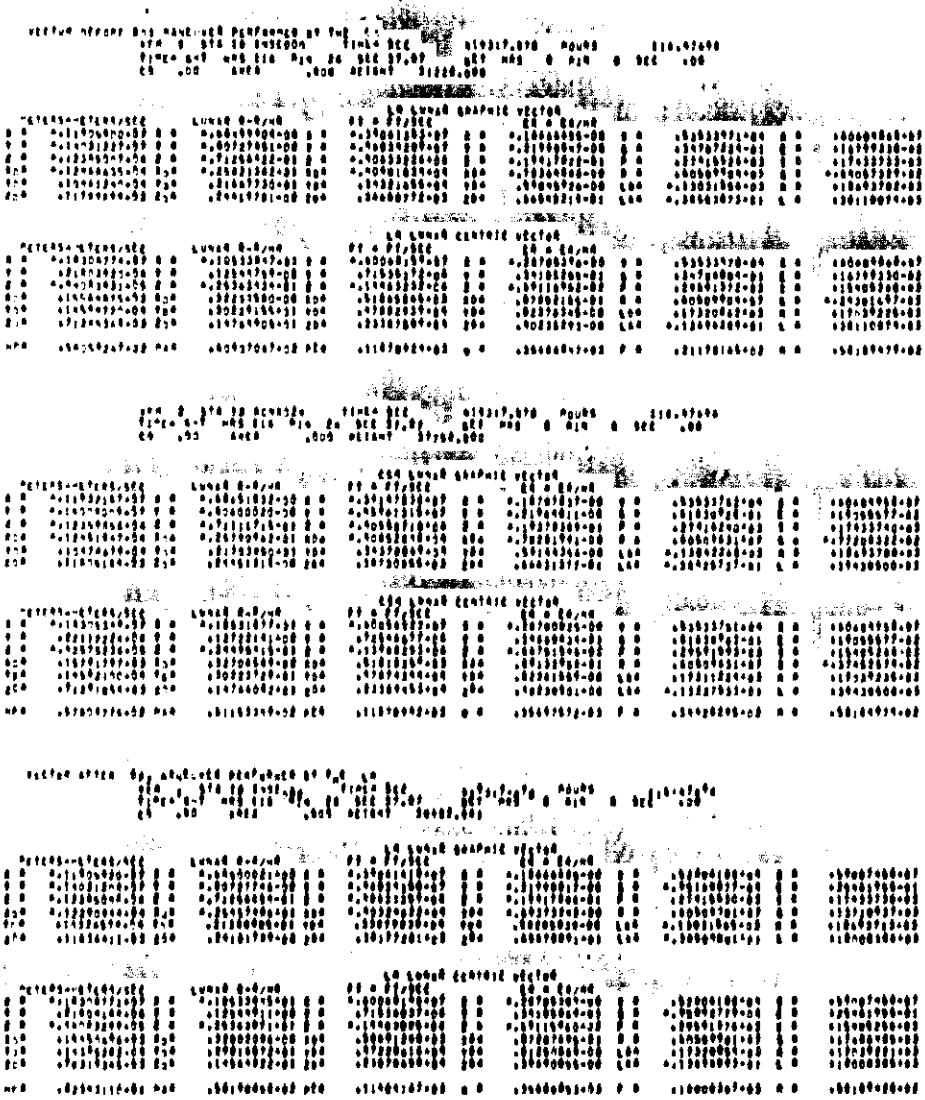


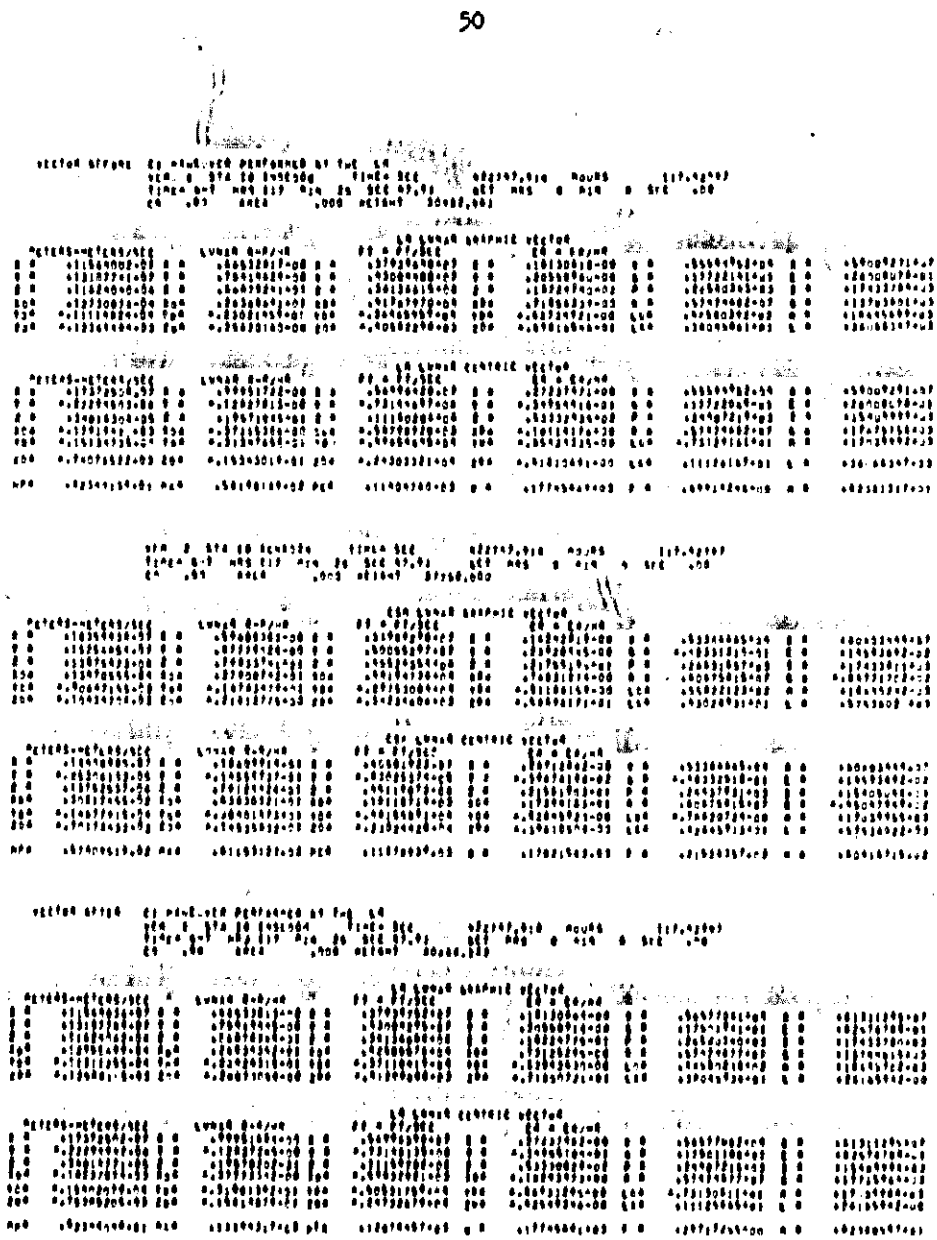
Figure 3.– Relative motion (curvilinear, CSM-centered) for PDI abort after nominal DOI.

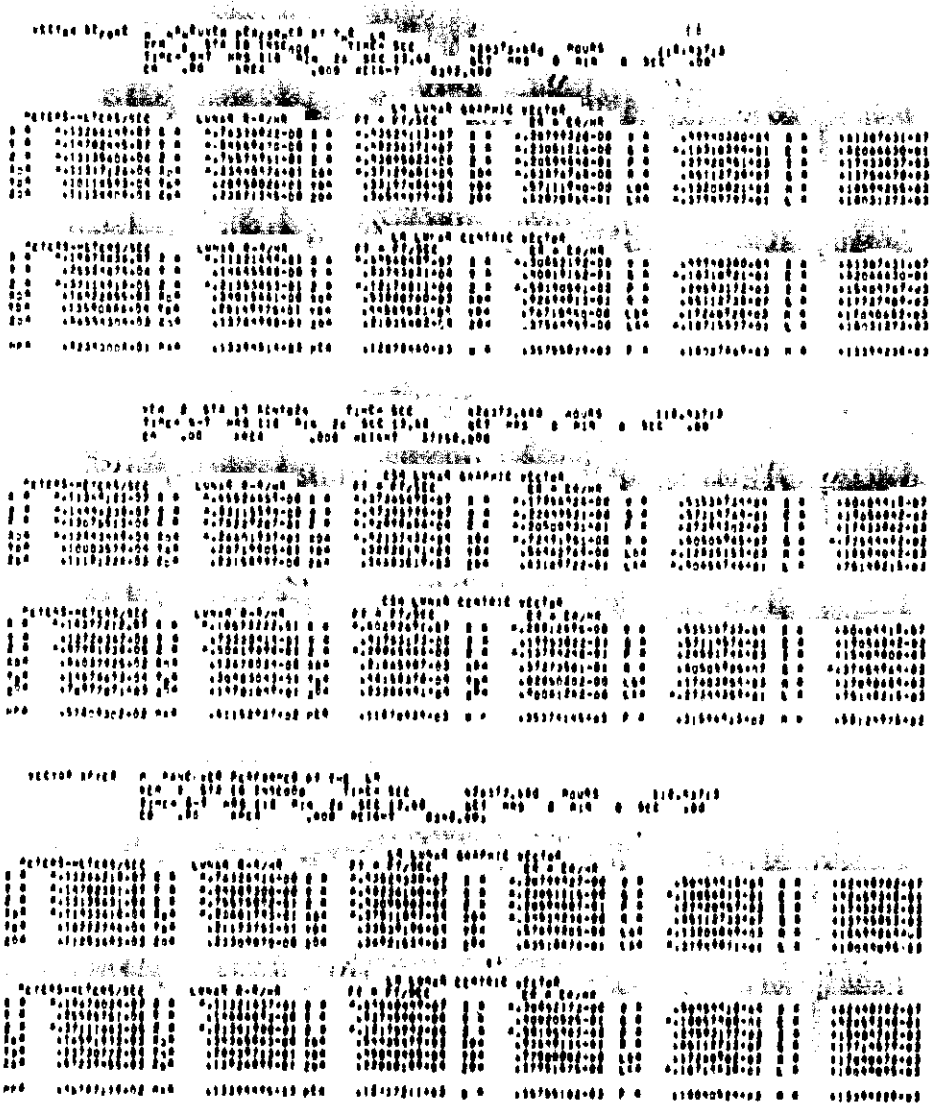
3.0 PDI ABORT AFTER A NOMINAL DOI MANEUVER

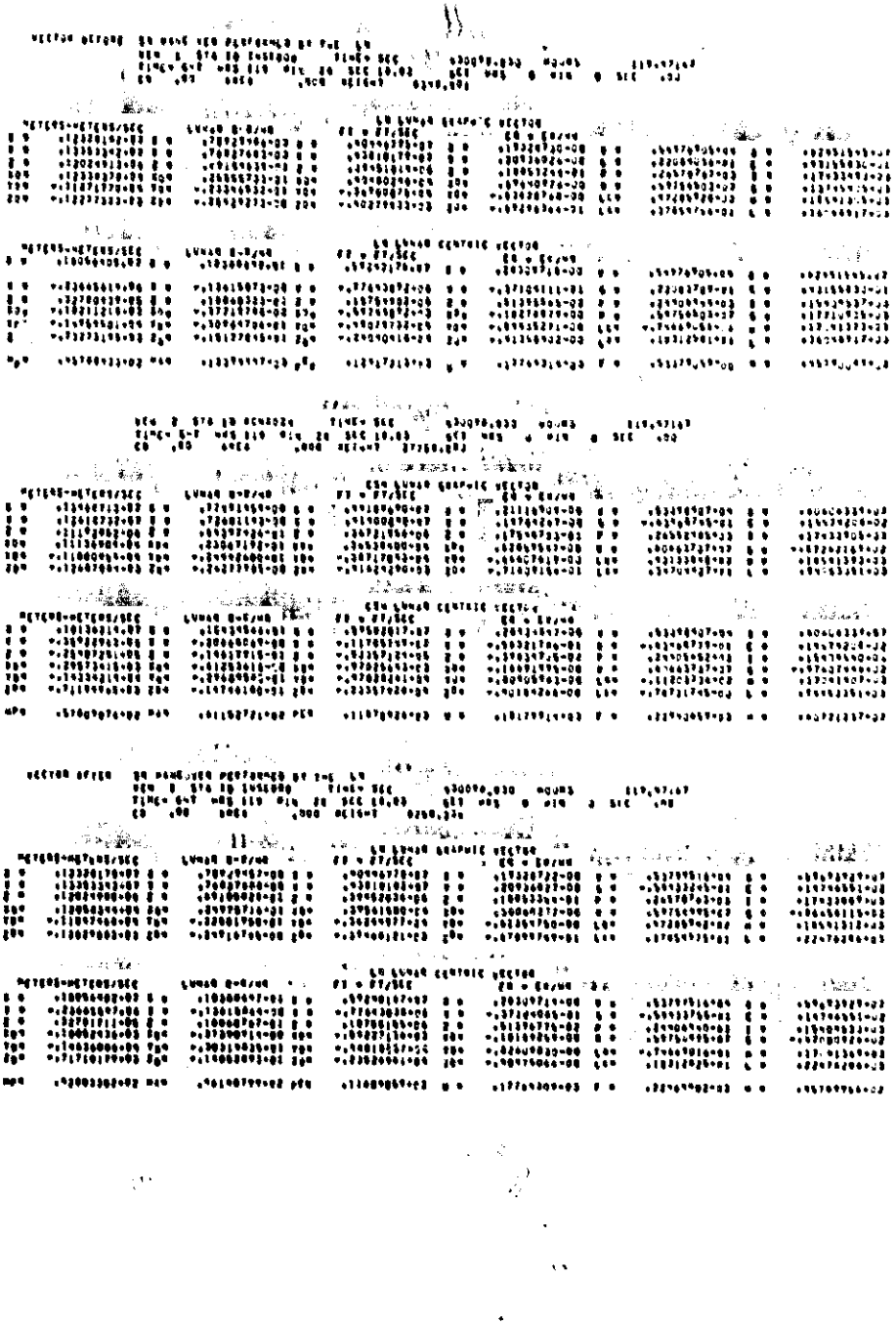
3.1 VECTORS

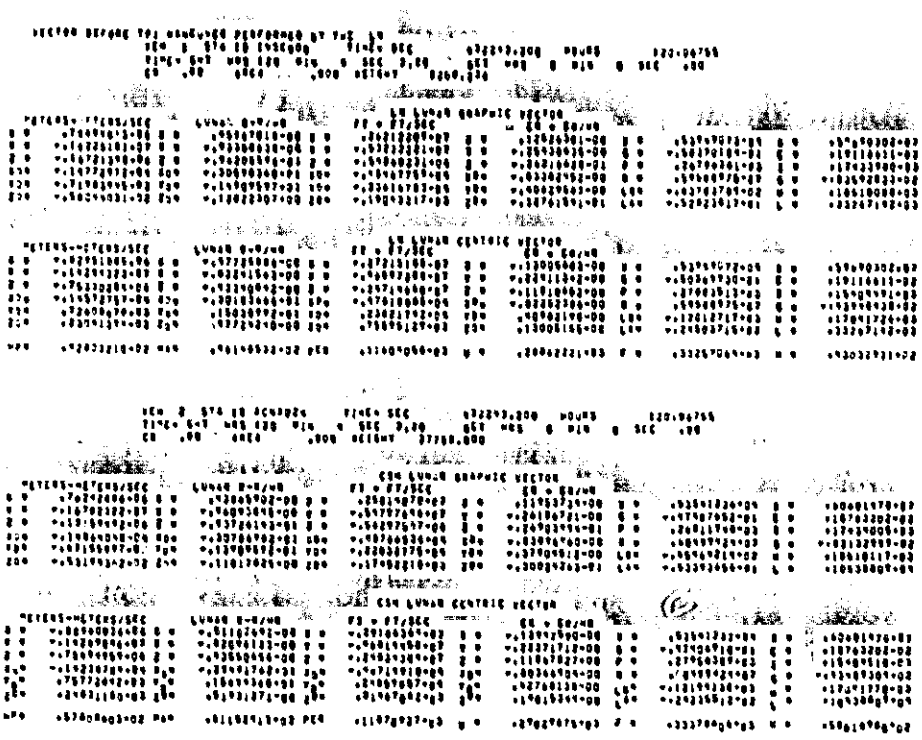


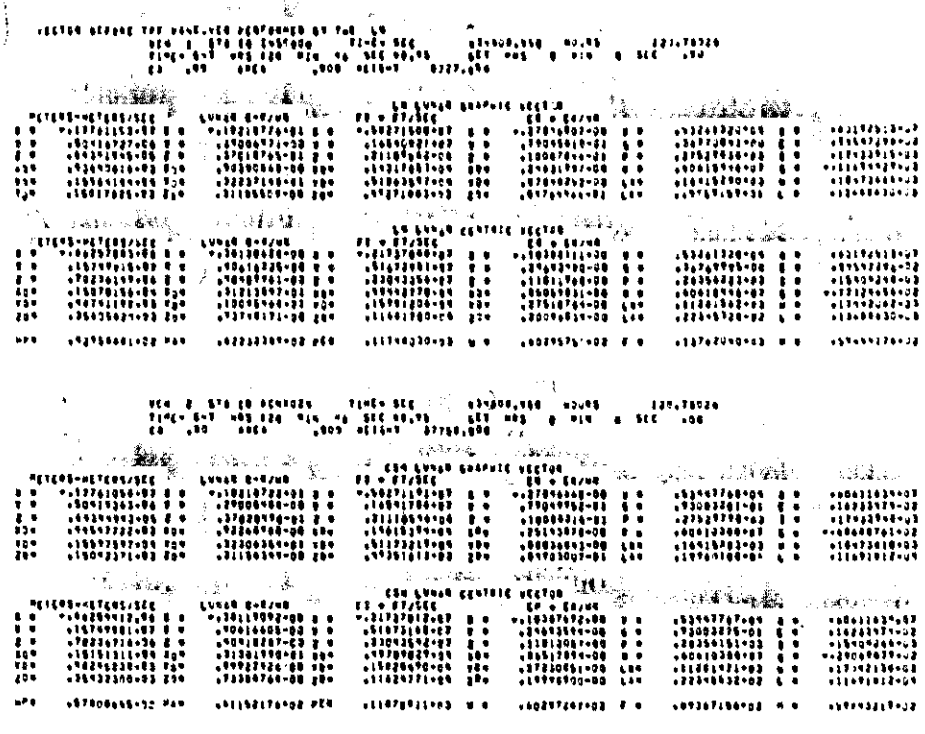












3.2 DETAILED MANEUVER TABLES

FDO DETAILED MANEUVER TABLE

```
C STA ID    ACM1021      L STA ID    LM5C000      L STA ID    00000MB      GT     31220.78
GMTV   116 20 40.4       GMTV   116 20 10.0       GMTV     0  0   .0       RC       500.00
GETV    98 56 57.8       GETV   102 54 28.7       GETV   -16+33+49.9        RL      5000.00
CODE     L0502 (51)      REF          LUNAR       SETM   -16+33+49.9        RP       500.00

GET1    99 54 27.2    DT B     0 36.8    DT TB     5.50     REFSMMAT      DEL P     9.8
PET1   116 20 10.0    DT M       0.00    DV TB     2.23       DCFLG       DEL Y     5.7
BVM       98.2        VGI       25.6     DT          .1      YB      .0    TM      -.8
BVMEM    907.8        VGT       -.8      IP     2849.8       PB      .0    PM     -1.3
BYC       96.0        VGC       96.1     HR      359.7       BB      .0    BM       .6

VF      -72.76     M B1      58.8      HA      86.193      VP          9559.58
VS        .98      P B1    3 54 0      HP       0.235      THETA P      -19.84
VD       1.92      L B1  129 16 .6     L AN   173 11 0     DELTA P        .00
RM      -.03        P B1      20.32     E    .02540196     P LLS     2 37 0
PHASE      .183                         I     170.3323     L LLS    34  3 C
PHASE DOT   -14.72      0 20.0          OP    137.1891     R LLS       -.818
PEDGE ANG      .618       UNTIL
YB             .5000       DAY

                              TARGETS

PGYS                  ASS
EST BV    LM          EST BV    LM              LAMBERT              DVR
GET1    99 54 27.2    GET1    99 54 27.2    GET1    99 54 27.2     GET1    99 54 27.2
  VS      -72.7707      VS      -72.5725    V F                    APSIS      0
  VT        .0020       VT        .0019     E      +4471337.00     ELEV        .00
  VZ       2.1594       VZ       2.4468     I      -5283223.30     TPI     0  0   .0
                                             Z      +2672169.00     DT          0   .0
                                             C                .006  OPTION

DT AFTER    30992.96
```

FDO DETAILED MANEUVER TABLE

```
C STA ID    ACM1021      L STA ID    LM5C000      L STA ID    LM5C000      GT     30992.96
GMTV   116 20 40.4       GMTV   116 20 10.0       GMTV     0  0   .0       RC       500.00
GETV    98 56 57.8       GETV   102 54 28.7       GETV   -16+33+49.9        RL      5000.00
CODE     L0502 (51)      REF          LUNAR       SETM   -16+33+49.9        RP       500.00

GET1   100 51 34.7    DT B     0 36.8    DT TB     5.50     REFSMMAT      DEL P     9.8
PET1   117 24 24.3    DT M       0.00    DV TB     2.25       DCFLG       DEL Y     5.7
BVM       98.2        VGI       25.6     DT          .1      YB      .0    TM      -.8
BVMEM    907.8        VGT       -.8      IP     2849.8       PB      .0    PM     -1.3
BYC       96.0        VGC       96.1     HR      359.7       BB      .0    BM       .6

VF      75.19      M B1      6.8       HA      133.4*3      VP          9457.72
VS       -.00      P B1    3 54 0      HP       0.231       THETA P      -13.64
VD       2.24      L B1   69 54 .6     L AN   170 11 0     DELTA P        .00
RM      92.84      P B1      359.39      E    .00287679     P LLS     2 37 0
PHASE    352.758                         I     170.3376     L LLS    34  3 C
PHASE DOT    6.16      19  7.3          OP    137.9402     R LLS       -.818
PEDGE ANG      .818       UNTIL
YB             .0030       DARK

                              TARGETS

PGYS                  ASS
EST BV    LM          EST BV    LM              LAMBERT              DVR
GET1   100 51 34.7    GET1   100 51 34.7    GET1   100 51 34.7     GET1   100 51 34.7
  VS       98.1979      VS       98.1723    V F     2 32 58.6      APSIS      0
  VT       -.0018       VT        .0021     E      4041116.18      ELEV        .00
  VZ       1.7999       VZ       3.0271     I      5477277.48      TPI     0  0   .0
                                             Z      2669277.58      DT          0   .0
                                             C                .000  OPTION

DT AFTER    30684.22
```

FDO DETAILED MANEUVER TABLE

C STA ID	SCN1024	L STA ID	SNSE008	L STA ID	SNSE008	DT	8392.98
GMTV	115 20 00.0	GMTA	115 20 10.0	GMTE	0 0 .0	EC	500.00
GETV	90 05 51.8	GETA	102 04 20.7	GETE	-16-33-49.4	EL	5000.00
CODE	L4S0N(2)	REF	LUN48	GETE	-16-33-49.4	EF	500.00

GETI	101 02 22.2	DT D	0 0.0	DT TO	.00	REFSMMAT	DEL P	0.0
PETI	119 20 13.5	DT V	0.00	DV TO	2.17	DCFLN	DEL Y	0.0
DVM	57.9	VGX	-112.8	DY	359.9	YD	.0	YM	-.0
DVREM	949.6	VGY	.2	EP	180.0	PD	.0	PM	-.1
DVC	50.2	VGZ	-49.8	AN	.3	RD	.0	RM	.0

VF	51.98	N 83	183.0	HA	138.915	HP	5497.78
VS	.00	P 83	2 49 5	HP	48.742	THETA P	-13.63
VD	.00	L 83	101 58 0	L AN	179 11 0	DELTA P	.00
DN	-75.75	P 81	180.19	E	.0026 5938	P LLS	2 37 N
PHASE	356.190			I	179.3363	L LLS	34 3 E
PHASE DOT	15.04	TB 20.6		AP	137.9365	R LLS	-.818
PEDGE ANG	.818	UNTIL					
YD	.0000	BANK					

TARGETS

PANS		AXS					
EST DV	LN	EST DV	LN	LANDEST		HVR	
GETI	102 04 24.1	GETI	102 04 24.1	GETI	102 04 24.1	GETI	102 04 24.1
VI	-117.7955	RR	-117.7958	T F	0 24 58.6	APSIS	0
RT	-.0011	YY	-.0009	X	6275566.45	ELEV	.08
VE	7.6722	VZ	0.0382	Y	5337325.68	FPI	0 0 .0
				Z	2612556.38	RT	0 .0
				C	.000	OPTION	

RT AFTER 8393.98

FDO DETAILED MANEUVER TABLE

C STA ID	SCN1024	L STA ID	SNSE008	L STA ID	SNSE008	DT	8396.90
GMTV	115 20 00.0	GMTA	115 20 10.0	GMTE	0 0 .0	EC	500.00
GETV	90 05 51.8	GETA	102 04 20.7	GETE	-16-33-49.4	EL	5000.00
CODE	L4S0N(2)	REF	LUN48	GETE	-16-33-49.4	EF	500.00

GETI	102 04 24.1	DT D	0 0.0	DT TO	.20	REFSMMAT	DEL P	0.0
PETI	119 20 13.5	DT V	9.00	DV TO	2.17	DCFLN	DEL Y	0.0
DVM	118.0	VGX	-36.8	DY	179.9	YD	.0	YM	-180.0
DVREM	830.6	VGY	.7	EP	180.0	PD	.0	PM	-3.1
DVC	118.0	VGZ	-112.2	AN	.3	RD	.0	RM	.0

VF	-117.72	N 81	69.6	HA	96.109	HP	5296.05
VS	-.05	P 81	2 56 5	HP	32.603	THETA P	137.98
VD	7.20	L 81	97 31 E	L AN	179 11 0	DELTA P	.08
DN	15.01	P 81	.38	E	.0014 7966	P LLS	2 37 N
PHASE	9.156			I	179.3389	L LLS	34 3 E
PHASE DOT	-8.28	TB 58.6		AP	-96.6561	R LLS	-.818
PEDGE ANG	.818	UNTIL					
YD	.0000	BANK					

TARGETS

PANS		AXS					
EST DV	LN	EST DV	LN	LANDEST		HVR	
GETI	102 04 24.1	GETI	102 04 24.1	GETI	102 04 24.1	GETI	102 04 24.1
VI	-117.7955	RR	-117.7958	T F	0 24 58.6	APSIS	0
RT	-.0011	YY	-.0009	X	6275566.45	ELEV	.08
VE	7.6722	VZ	0.0382	Y	5337325.68	FPI	0 0 .0
				Z	2612556.38	RT	0 .0
				C	.000	OPTION	

RT AFTER 8250.29

FDO DETAILED MANEUVER TABLE

```
C STA ID   ACN7824        L STA ID   EMSE000      L STA ID   EMSE000      ST      8227.44
GMTI    118 20 00.0     GMTV    119 20 10.0     GMTV      0  0   .0     RC       500.00
GETV     98 55 51.0     GETV    102 54 20.2     GETV   -16-33-49.5     RL      5000.78
CODE       LR60(P)      REF          LUNAR     GETR   -16-33-49.5     RF       500.00

GETI   103 39 13.0    DT B     0 15.0   DT TO     .00    REVSNMAT     DEL P     .0
PETI   120  6  3.3    DT M      .00     DV TO     .00      DCFLG      DEL V     .0
RYN       29.6        VLH      -23.1    DT       750.7    VS    .0   VH       -.1
RYMCN    975.2        FGT       -.1     ZP       249.5    PS    .0   PH      37.0
RYC       29.6        VGE       0.0     HR       357.8    RS    .0   RH       .0

VF      22406        H 01      93.0     HA       62.233    VP          5419.39
VS       -.02        P 01    5 26 5     HP       97.996    THETA P      97.11
VD     -11.26        L 01   43 47 0     L AN   175 53 2    DELTA P       .00
DH      15.02        P 02      332.87    E     .0009511$    P LLS    2 37 0
PHASE     1.675                          I      170.3107    L LLS    34  5 E
PHASE DOT    +3.72     03 36.7           HP    -117.9383    R LLS       -.818
RDOGE ANG     .819       UNTIL
YB            .7000       DAY

                              TARGETS

PWNS                  ASS
EST BV    LN          EST BV    LN                 LANGEST              HAN   TPI
GETI   103 39 13.0    GETI   103 39 13.0   GETI   103 39 13.0    GETI   103 39 13.0
  XE        .0000       VE       21.9671   T F      1 28 32.5    APSIS      0
  VE        .0008       VV        -.0246     I    51279239.78    CLEV      28.68 N
  VZ        .0000       VZ      -11.2073     F   -24677836.88    TPI    103 39 13.0
                                             Z    -8391902.26     DT        42 55.0
                                             C         .000   OPTION    TCLEV

DT AFTER     8227.44
```

FDO DETAILED MANEUVER TABLE

```
C STA ID   ACN7824        L STA ID   EMSE000      L STA ID   EMSE000      ST      8227.44
GMTI    118 20 00.0     GMTV    119 20 10.0     GMTV      0  0   .0     RC       500.00
GETV     98 55 51.0     GETV    102 54 20.2     GETV   -16-33-49.5     RL      5000.78
CODE       LR60(P)      REF          LUNAR     GETR   -16-33-49.5     RF       500.00

GETI   104 12 59.6    DT B     0 39.5   DT TO     .00    REVSNMAT     DEL P     .0
PETI   120 46 49.8    DT M      .0C     DV TO     .00      DCFLG      DEL V     .0
RYN       33.1        VLH      -31.0    DT       690.1    VS    .0   VH       -.1
RYMCN    949.2        FGT       -.1     ZP        78.8    PS    .0   PH      33.3
RYC        .8         VGE       0.0     HR        -.3     RS    .0   RH     180.8

VF      18490        H 01      59.8     HA       61.202    VP          5359.28
VS       -.05        P 01    1 59 8     HP       97.792    THETA P      127.33
VD      25.89        L 01   169  8 E     L AN   174 12 8    DELTA P       .00
DH       -.08        P 02      337.62    E     .0016$307    P LLS    2 37 0
PHASE      .073                          I      170.3395    L LLS    34  5 E
PHASE DOT     .01     52 47.1           HP    -70.9758     R LLS       -.818
RDOGE ANG     .818       UNTIL
YB            .0000       DARK

                              TARGETS

PWNS                  ASS
EST BV    LN          EST BV    LN                 LANGEST              HAN   TPI
GETI   104 12 59.6    GETI   104 12 59.6   GETI   104 12 59.6    GETI   104 12 59.6
  XE        .0000       VE      18,2985   T F      2 29  7.7    APSIS      0
  VE        .0006       VV        -.0378     I    -8631535.78    CLEV      .00
  VZ        .0009       VZ      25,6879      F   -1703809.68    TPI     0  0   .0
                                             Z   -13129953.00    DT        0   .0
                                             C         .000   OPTION

DT AFTER     8199.42
```

3.3 SUNRISE-SUNSET TABLES

LH LIGHTING TABLE

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S

THE LH WAS BEEN MANEUVERED
PURPOSE ROE AT A GMT OF 116 26 37.5
GET OF 89 54 47.7

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
99	54	7.42	101	2	43.93
101	53	7.16	102	55	43.62

THE LH WAS BEEN MANEUVERED
PURPOSE ES AT A GMT OF 117 25 47.9
GET OF 100 51 50.5

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
102	50	6.78	101	2	13.78
105	49	50.13	103	2	57.61

THE LH WAS BEEN MANEUVERED
PURPOSE M AT A GMT OF 118 26 19.7
GET OF 101 52 24.3

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
102	54	13.90	103	0	3.21
105	54	29.36	105	10	18.10

THE LH WAS BEEN MANEUVERED
PURPOSE SR AT A GMT OF 119 25 18.8
GET OF 102 54 28.7

(Continued)

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
102	54	10.31	103	2	32.11
105	50	33.38	105	3	51.05

THE LH WAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 120 4 3.2
GET OF 103 38 12.8

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
103	53	50.59	105	5	19.54
105	51	55.75	107	2	34.69

THE LH WAS BEEN MANEUVERED
PURPOSE TPF AT A GMT OF 120 46 49.1
GET OF 104 12 59.6

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
105	52	3.63	105	5	59.52
107	50	40.92	107	0	36.10
109	49	20.13	109	3	17.41
111	47	59.56	111	1	56.91
113	46	36.84	113	0	36.22

CSM LIGHTING TABLE

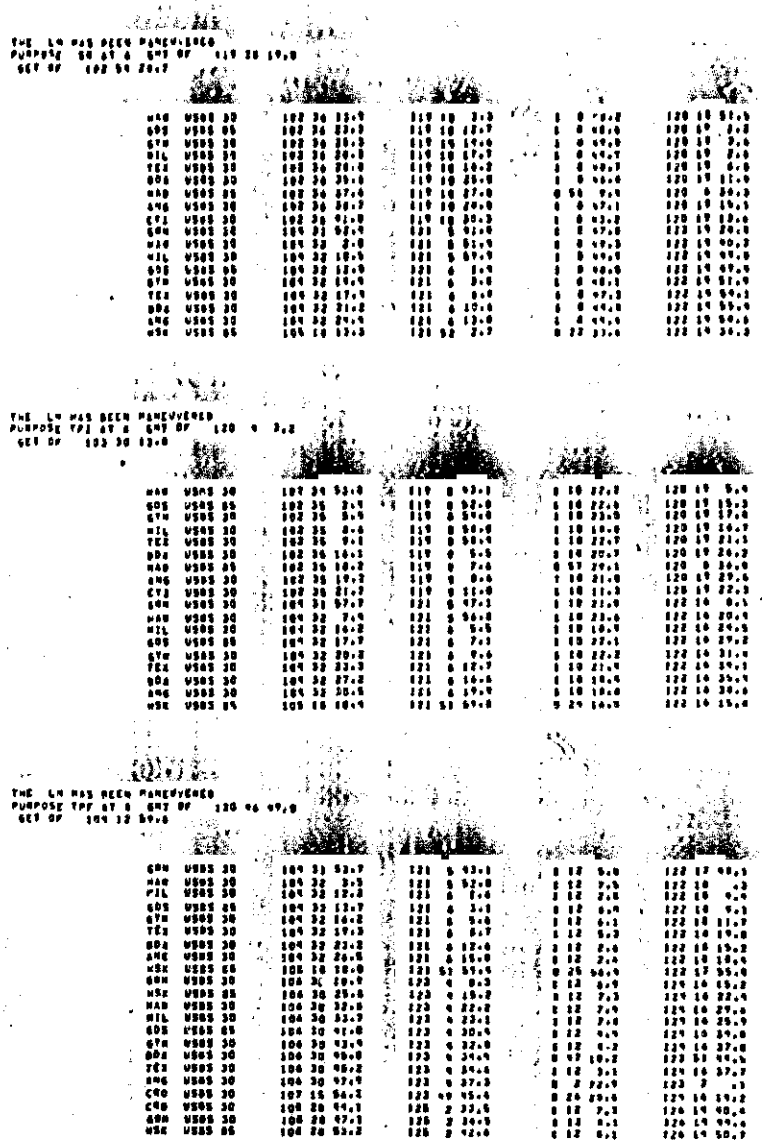
LIGHTING TABLE

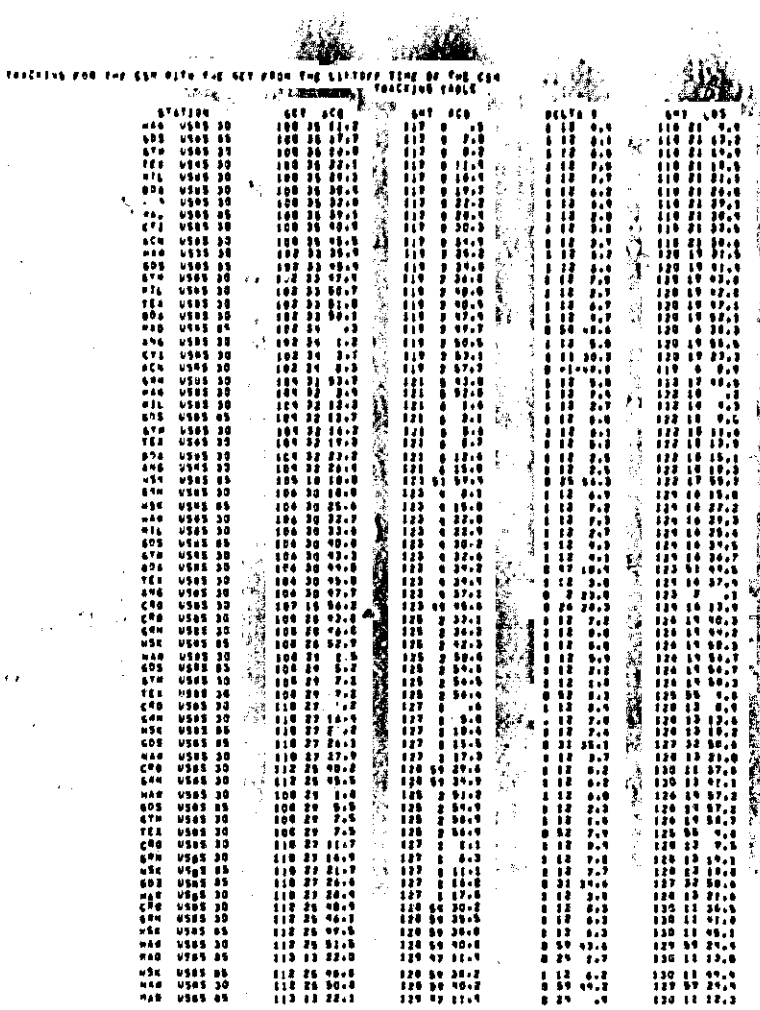
GET SUNRISE			GET SUNSET		
M	H	S	M	H	S
99	56	4.41	101	0	42.63
101	55	42.34	103	1	19.43
103	53	22.48	105	4	56.06
105	52	2.63 C	107	1	37.42
107	50	40.78	109	2	14.37
109	49	19.92	111	1	54.11
111	47	59.06	113	0	35.25

3.4 MSFN DEEP-SPACE TRACKING

TRACKING FOR THE LM DISH THE SEY FROM THE LIFTOFF TIME OF THE CSM TRACKING TABLE

STATION		GET AOS	GMT AOS	DELTA V	GMT LOS
THE LM HAS BEEN MANEUVERED PURPOSE DOI AT A GMT OF 116 20 37.15 GET OF 99 54 47.7					
HAW	USNS 30	100 37 33.0	117 11 12.7	1 5 0.0	118 10 19.0
GDS	USNS 85	100 37 38.0	117 11 17.8	1 5 0.0	118 10 23.9
GYM	USNS 30	100 37 37.6	117 11 20.0	1 5 0.0	118 10 24.0
TEX	USNS 30	100 37 34.0	117 11 24.1	1 5 0.0	118 10 33.0
HIL	USNS 30	100 37 41.0	117 11 31.3	1 5 0.0	118 10 36.1
BDA	USNS 30	100 37 42.0	117 11 32.5	1 5 0.0	118 10 40.0
ANG	USNS 30	100 37 45.7	117 11 35.3	1 5 0.0	118 10 44.0
MAD	USNS 65	100 37 51.0	117 11 41.0	1 5 0.0	118 10 45.7
CYI	USNS 30	100 37 53.0	117 11 43.1	1 5 0.0	118 10 49.0
ACN	USNS 30	100 37 58.0	117 11 47.9	1 5 0.0	118 10 54.0
HAW	USNS 30	102 31 0.0	119 9 57.5	1 5 0.0	120 10 5.2
GDS	USNS 85	102 31 10.1	119 9 7.5	1 5 0.0	120 10 15.0
GYM	USNS 30	102 31 20.1	119 9 9.5	1 5 0.0	120 10 18.9
HIL	USNS 30	102 31 23.0	119 9 13.0	1 5 0.0	120 10 17.0
TEX	USNS 30	102 31 23.0	119 9 13.2	1 5 0.0	120 10 21.9
BDA	USNS 30	102 31 31.0	119 9 20.9	1 5 7.0	120 10 27.0
MAD	USNS 65	102 31 33.0	119 9 22.7	1 5 7.0	120 0 29.9
CYI	USNS 30	102 31 39.0	119 9 27.0	1 5 7.0	120 10 30.9
ACN	USNS 30	102 31 46.0	119 9 34.1	1 5 7.0	120 10 37.9
		102 31 42.0	119 9 37.0	0 0 15.4	119 9 44.3
THE LM HAS BEEN MANEUVERED PURPOSE CSI AT A GMT OF 117 25 49.0 GET OF 100 51 56.5					
HAW	USNS 30	100 36 20.0	117 10 10.2	1 12 12.0	118 22 27.2
GDS	USNS 85	100 36 26.2	117 10 17.0	1 12 14.2	118 22 31.0
GYM	USNS 30	100 36 29.5	117 10 20.0	1 12 14.1	118 22 34.0
TEX	USNS 30	100 36 33.1	117 10 22.5	1 12 13.6	118 22 38.1
HIL	USNS 30	100 36 41.9	117 10 30.0	1 12 14.5	118 22 41.2
BDA	USNS 30	100 36 42.9	117 10 32.3	1 12 14.5	118 22 46.0
ANG	USNS 30	100 36 46.0	117 10 35.1	1 12 15.3	118 22 50.0
MAD	USNS 65	100 36 52.7	117 10 42.1	1 12 9.7	118 22 51.8
CYI	USNS 30	100 36 54.8	117 10 44.0	1 12 11.1	118 22 55.0
ACN	USNS 30	100 37 0.0	117 10 49.0	1 12 12.0	118 23 0.0
HAW	USNS 30	102 36 47.1	119 10 36.0	1 12 12.9	120 22 50.2
GDS	USNS 85	102 36 57.1	119 10 47.1	1 12 14.0	120 23 0.0
GYM	USNS 30	102 37 0.5	119 10 49.0	1 12 14.0	120 23 4.0
HIL	USNS 30	102 37 9.0	119 10 53.5	1 12 14.0	120 23 8.0
TEX	USNS 30	102 37 9.0	119 10 59.0	1 12 14.0	120 23 8.0
BDA	USNS 30	102 37 12.5	119 11 1.9	1 12 12.0	120 23 15.0
MAD	USNS 65	102 37 19.0	119 11 9.2	0 55 41.0	120 0 46.1
ANG	USNS 30	102 37 18.1	119 11 9.5	1 12 12.0	120 23 18.0
CYI	USNS 30	102 37 18.0	119 11 9.1	1 0 24.0	120 13 32.1
THE LM HAS BEEN MANEUVERED PURPOSE H AT A GMT OF 118 26 13.7 GET OF 101 52 24.3					
HAW	USNS 30	102 35 18.0	119 9 0.2	1 17 9.0	120 26 17.2
GDS	USNS 85	102 35 27.0	119 9 10.0	1 17 9.5	120 26 26.5
GYM	USNS 30	102 35 31.0	119 9 21.1	1 17 10.2	120 26 31.3
HIL	USNS 30	102 35 38.0	119 9 29.6	1 17 9.1	120 26 39.2
TEX	USNS 30	102 35 38.7	119 9 29.1	1 17 10.0	120 26 38.1
BDA	USNS 30	102 35 43.9	119 9 33.7	1 17 7.0	120 26 40.0
MAD	USNS 65	102 35 48.7	119 9 38.0	0 57 14.0	120 0 49.6
ANG	USNS 30	102 35 46.3	119 9 38.1	1 17 6.0	120 26 46.0
CYI	USNS 30	102 35 49.5	119 9 38.5	1 18 2.0	120 17 48.7
GBM	USNS 30	104 39 1.5	121 12 50.9	1 17 5.0	122 29 56.1
HAW	USNS 30	104 39 12.9	121 13 1.6	1 17 9.0	122 30 10.6
HIL	USNS 30	104 39 21.5	121 13 10.9	1 17 3.9	122 30 19.3
GDS	USNS 85	104 39 23.0	121 13 13.0	1 17 7.0	122 30 20.0
GYM	USNS 30	104 39 26.3	121 13 15.7	1 17 8.1	122 30 23.0
TEX	USNS 30	104 39 29.6	121 13 19.0	1 17 7.0	122 30 26.2
BDA	USNS 30	104 39 33.6	121 13 23.0	1 17 9.1	122 30 27.1
ANG	USNS 30	104 39 37.2	121 13 26.5	1 17 9.0	122 30 30.6
ASC	USNS 85	105 17 55.0	121 51 45.2	0 36 20.4	122 30 9.6





4.0 PDI ABORT AFTER A PARTIAL DOI MANEUVER OF 40 FPS

TABLE IV.- SUMMARY OF SEQUENCE OF EVENTS FOR A PDI ABORT INITIATED AFTER A PARTIAL DOI MANEUVER OF 40 FPS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	DOI	DPS (40%)	--
LM	Abort initiation (C1)[b]	APS	1/2
LM	CSI (H)[b]	APS or LM RCS	1/2
LM	CDH (SR)[b]	APS or LM RCS	1/2
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI one revolution earlier than nominal time.

[b]The printout maneuver terminology is given in parentheses.

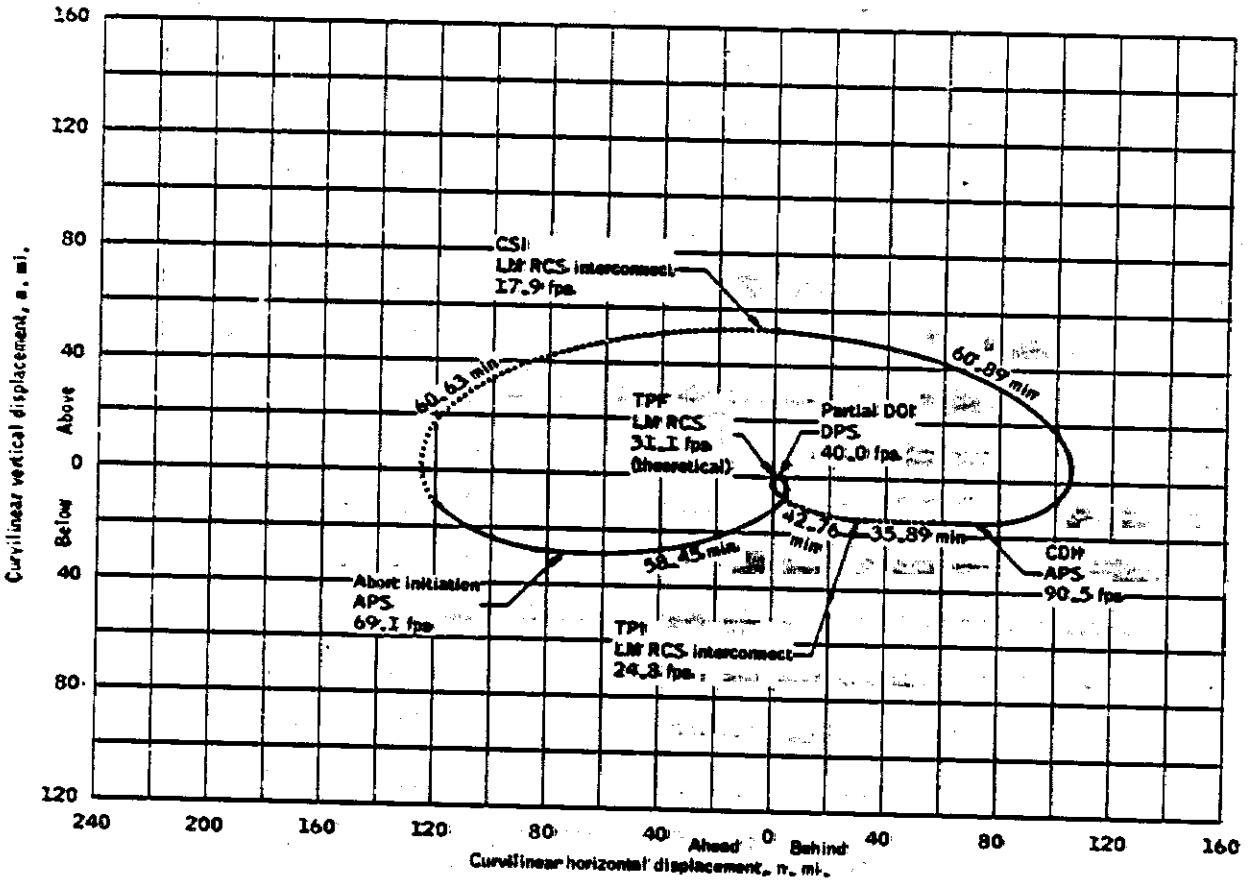
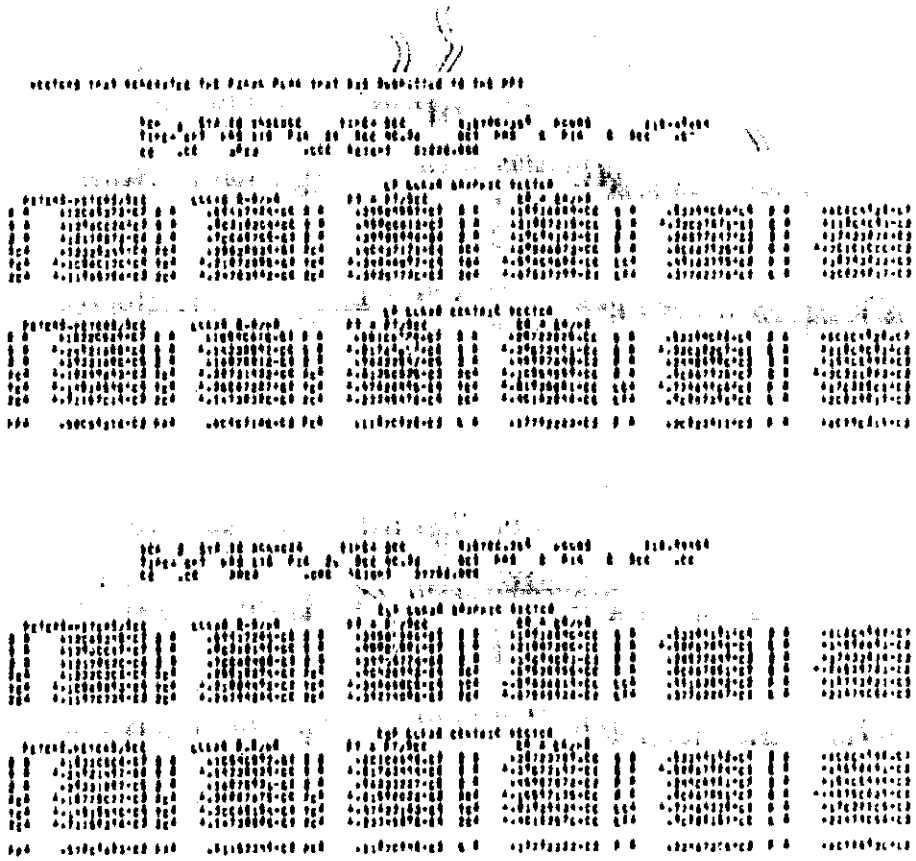
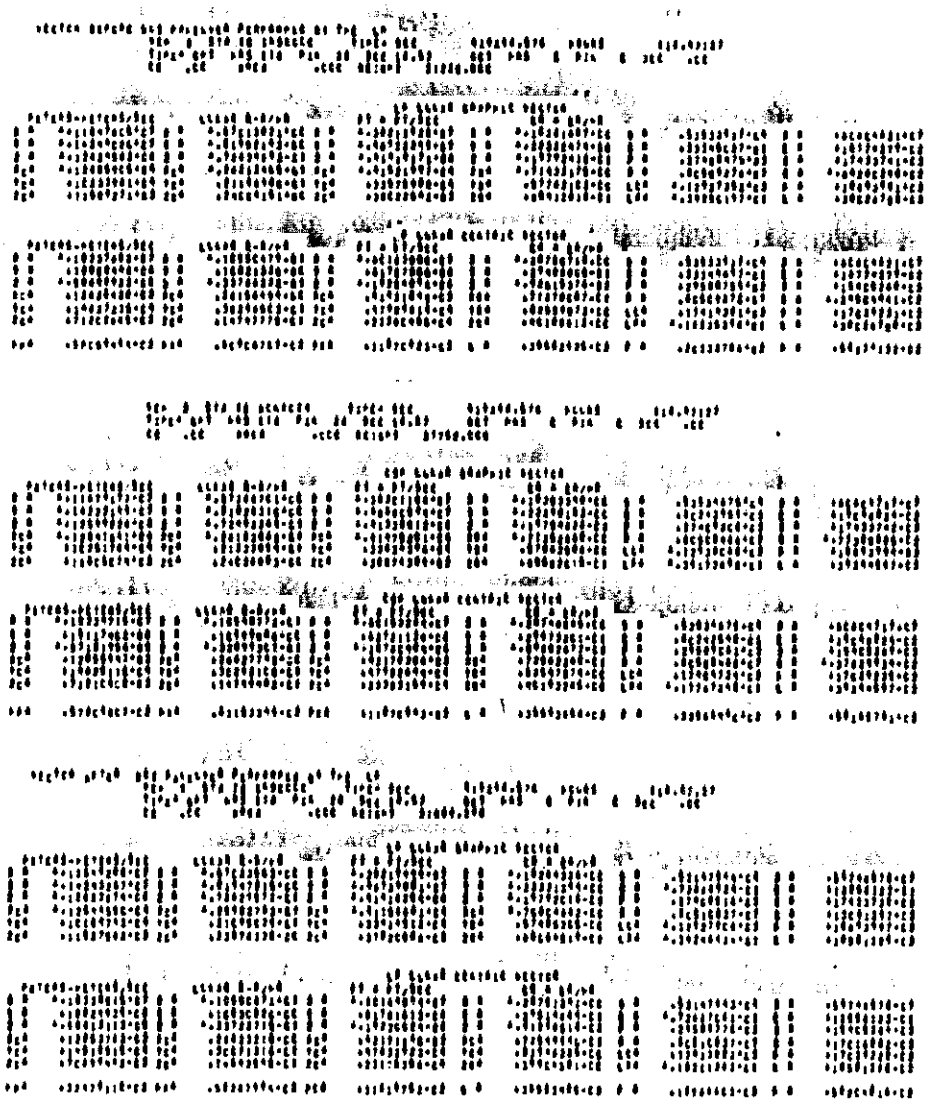


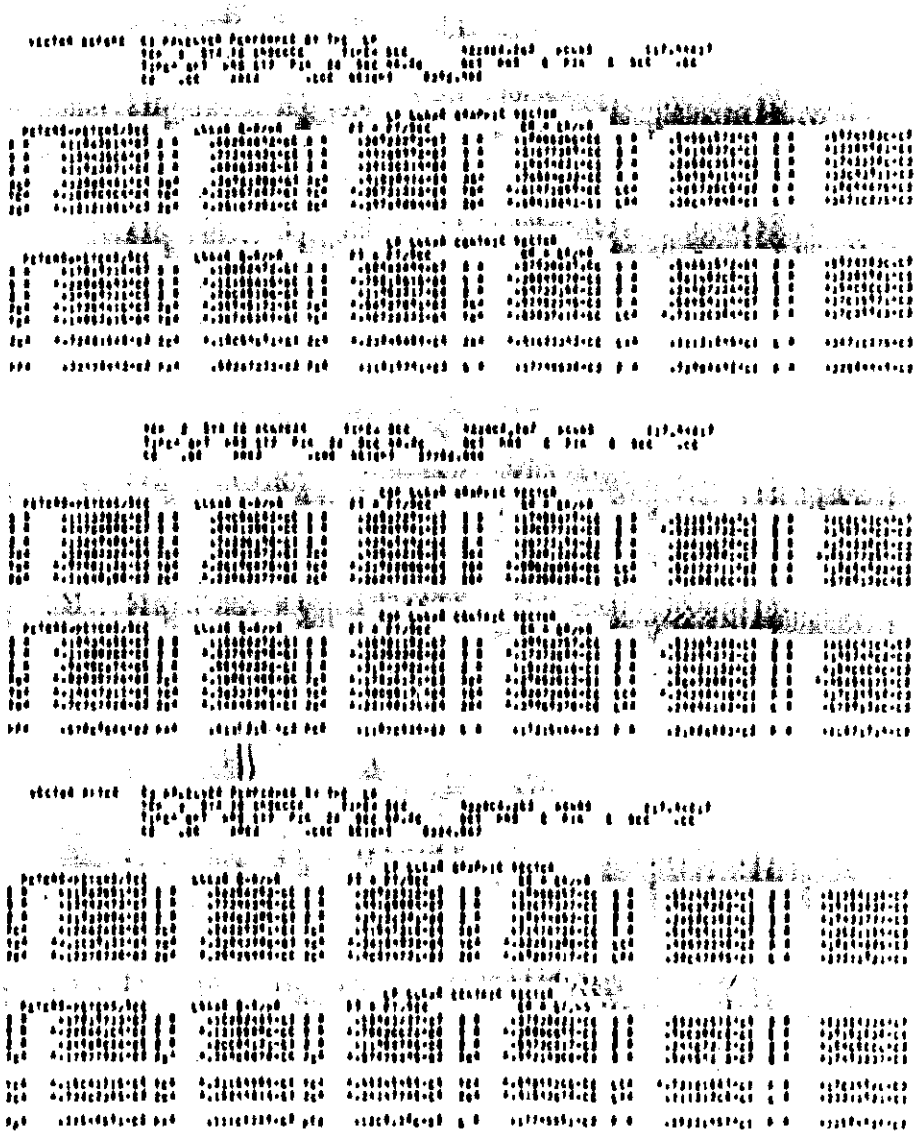
Figure 4.- Relative motion (curvilinear, CSM-centered) for PDI abort after a partial DOI of 40 fps.

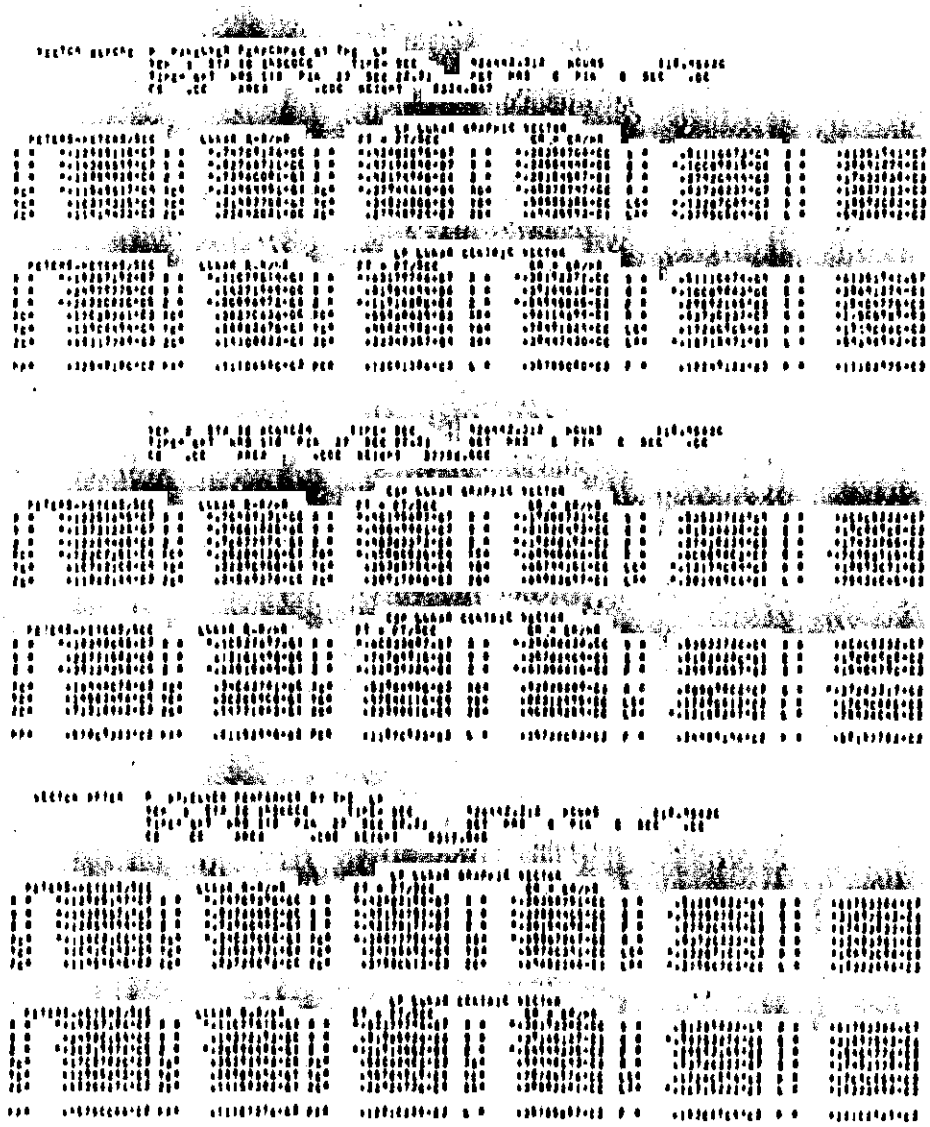
4.8 PDI ABORT AFTER A PARTIAL DOI MANEUVER OF 40 FPS

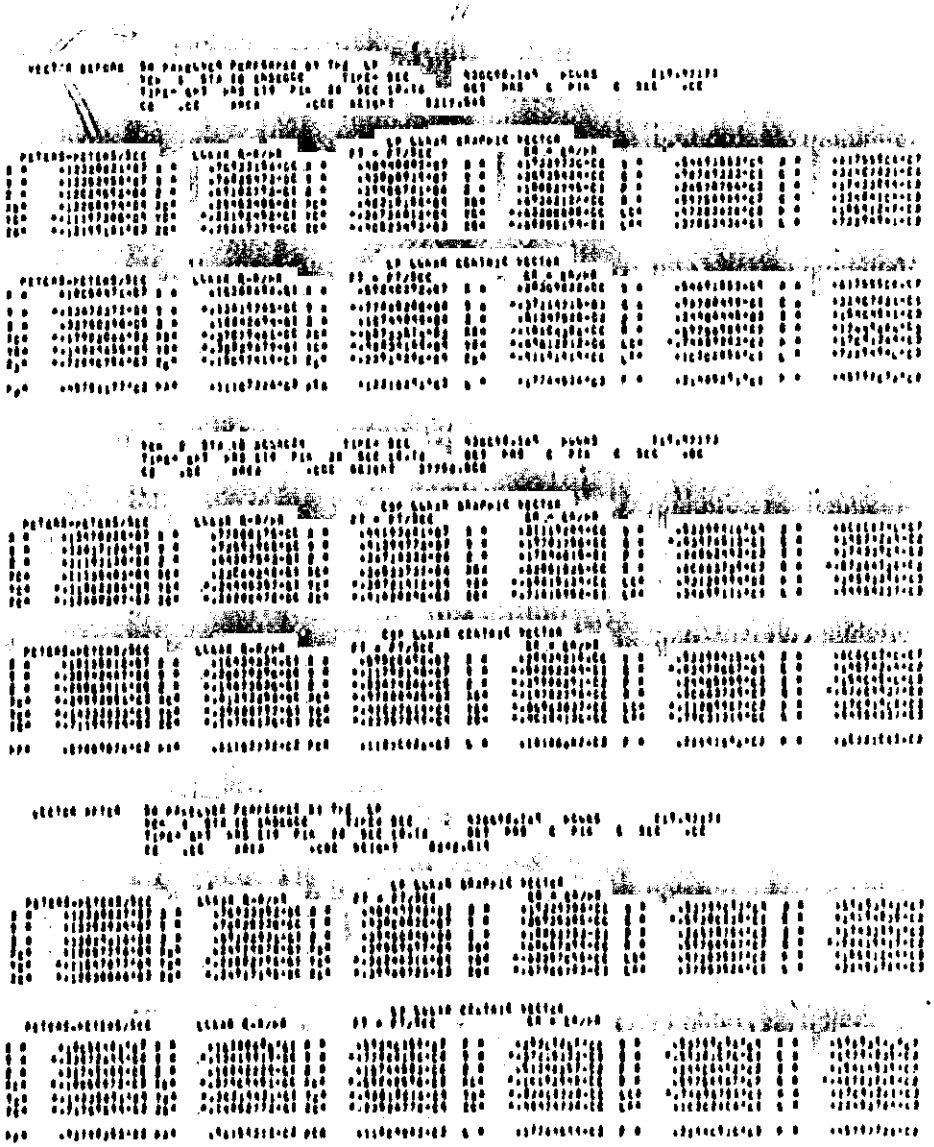
4.1 VECTORS

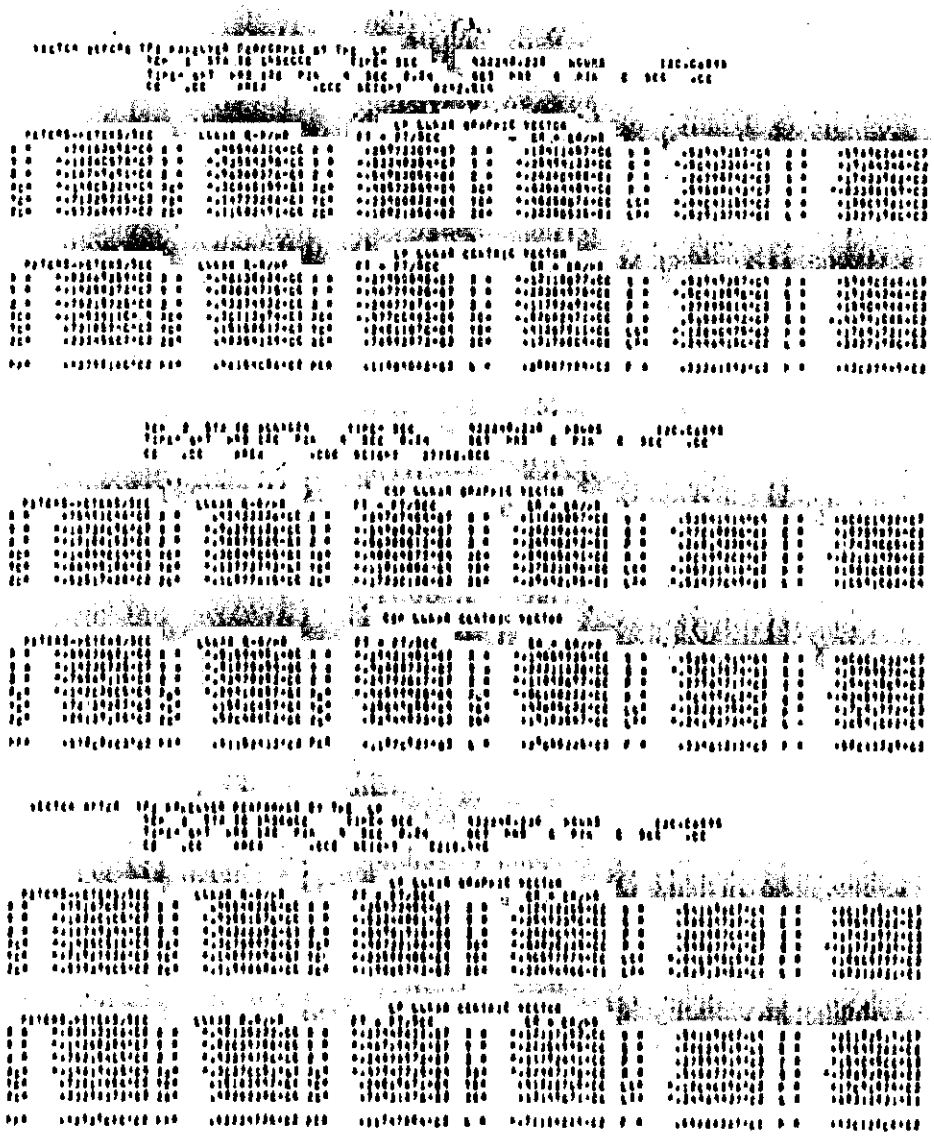


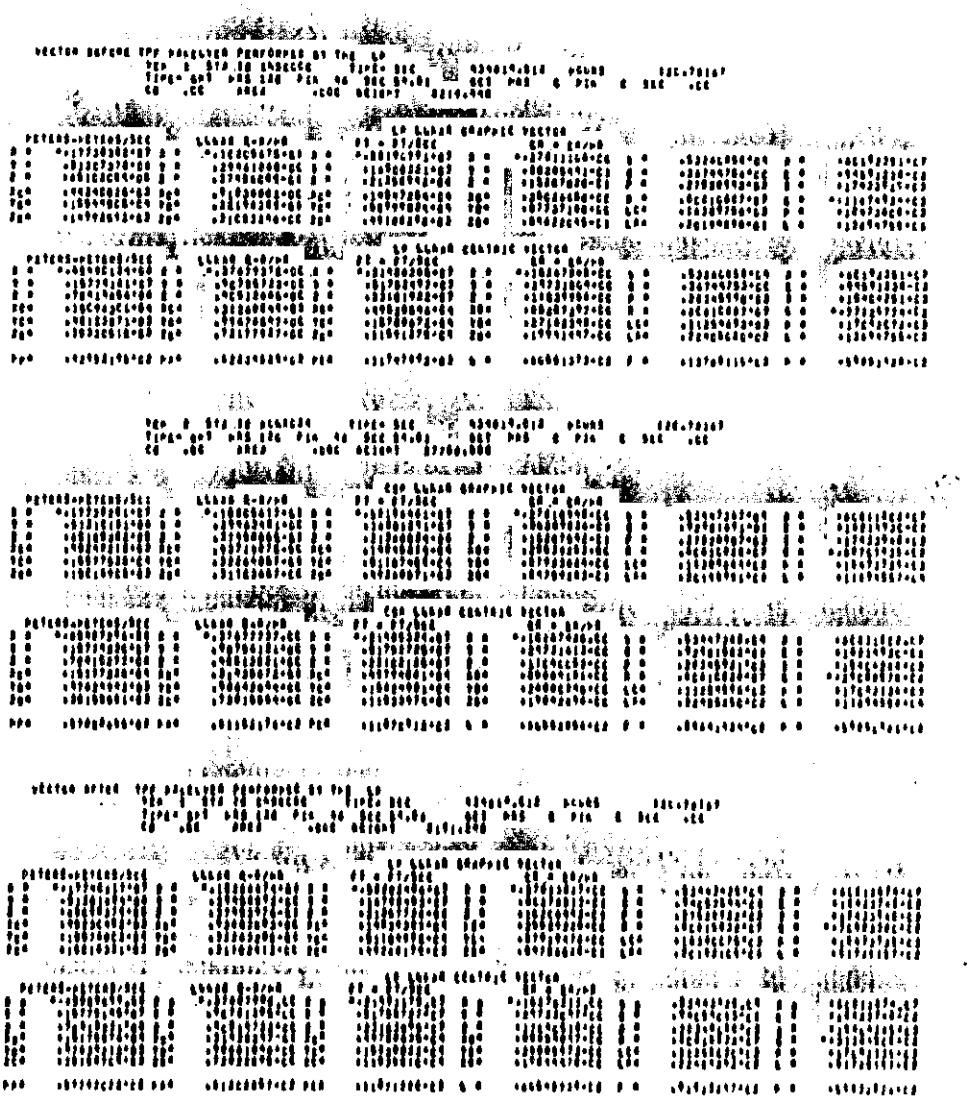




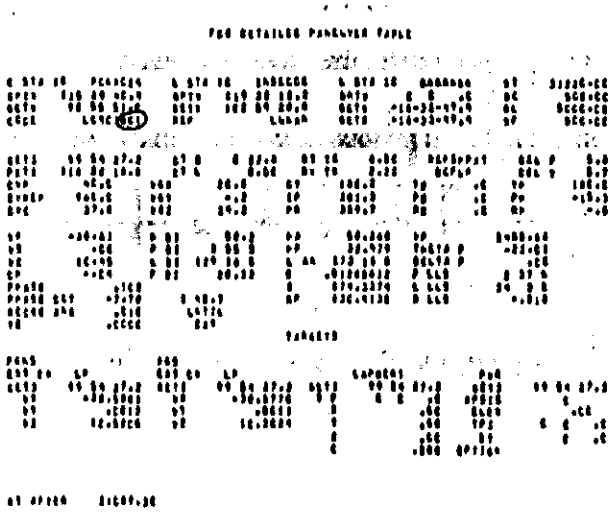


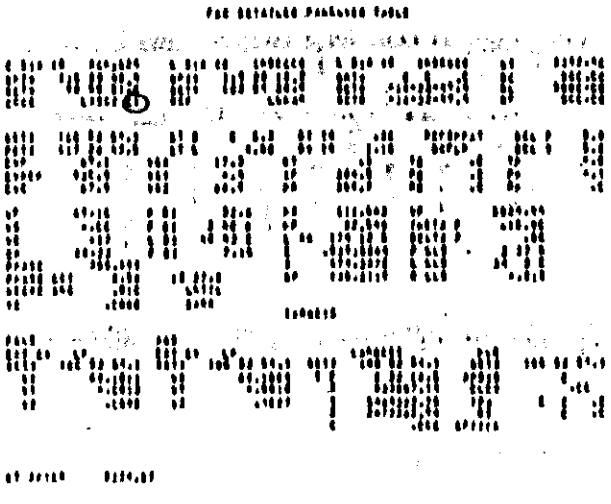


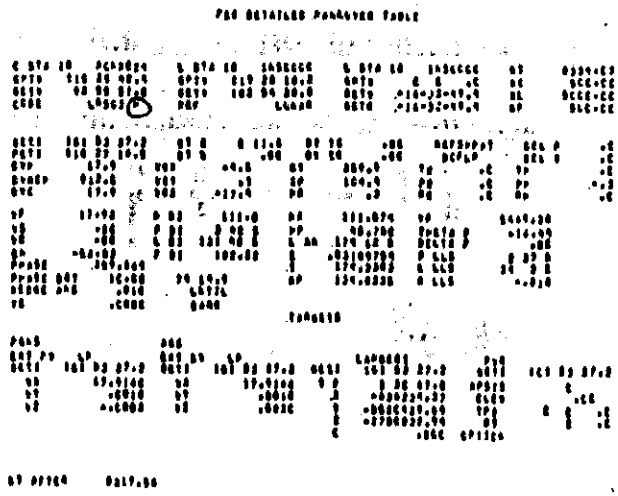


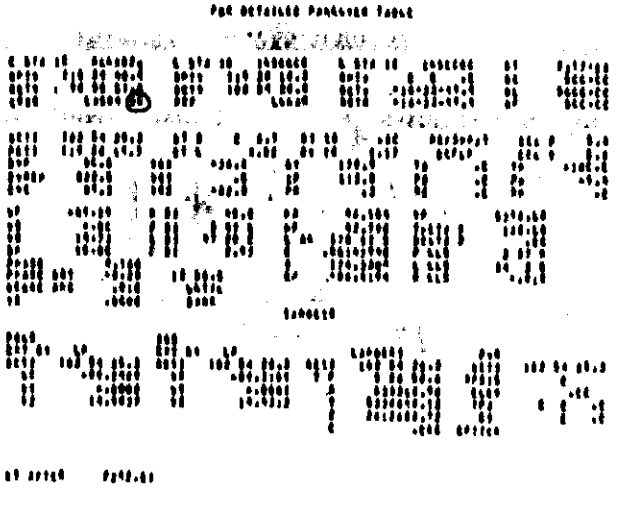


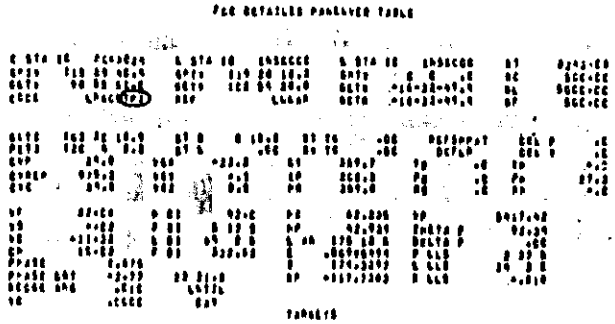
4.2 DETAILED MANEUVER TABLES

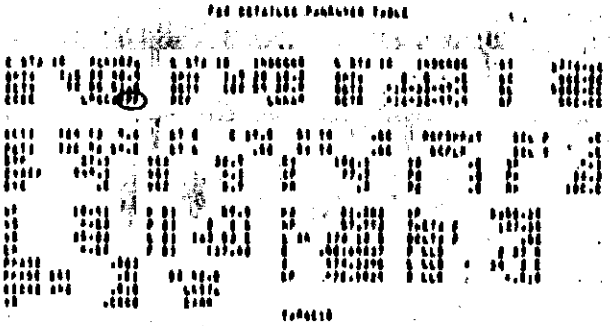




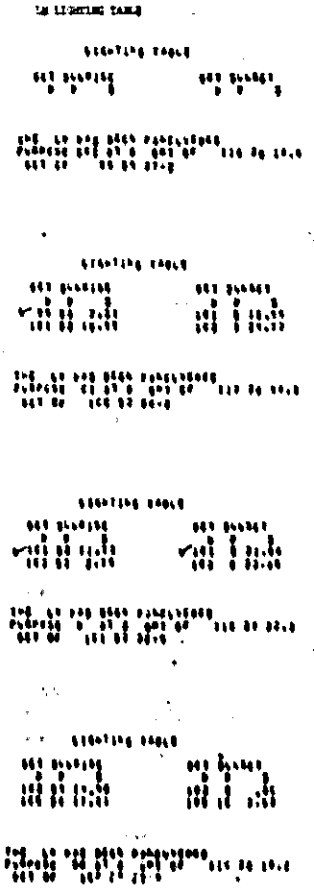


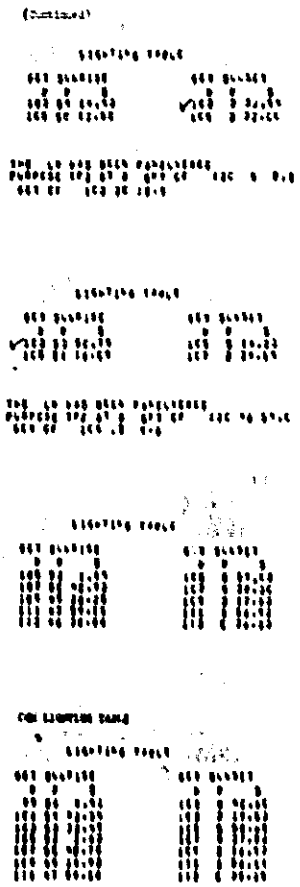




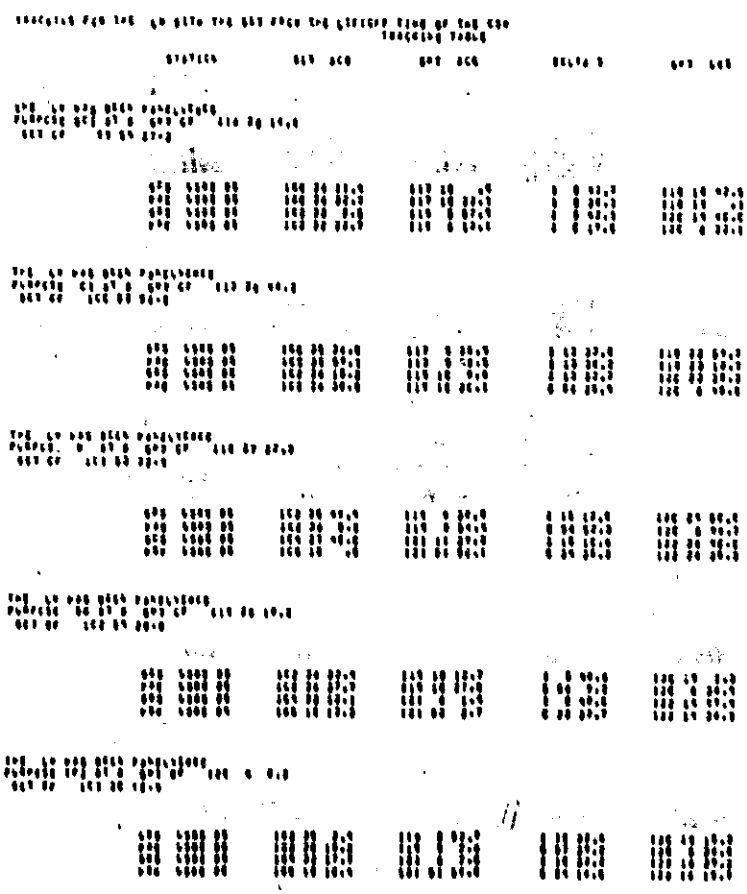


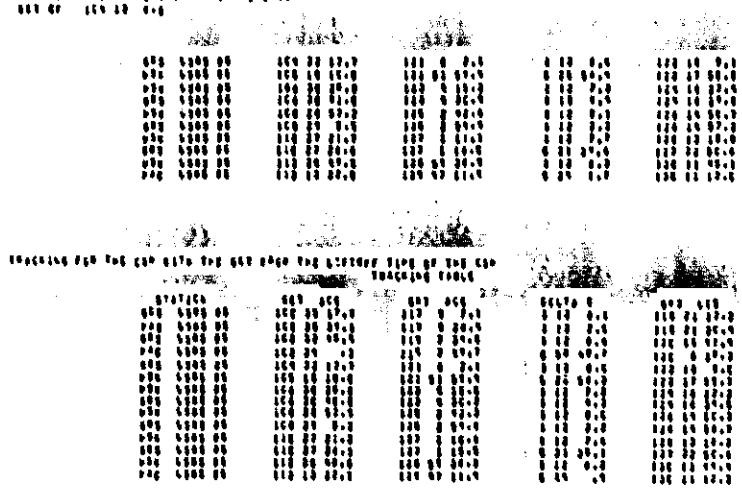
4.3 SUNRISE-SUNSET TABLES





4.4 MSFN DEEP-SPACE TRACKING





5.0 RESCUE AFTER A ZERO PHASING MANEUVER

TABLE V.- SUMMARY OF SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A ZERO PHASING MANEUVER[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	PHA	-- --	2/3
CSM	Rescue initiation (R)[b]	SPS	1/3
CSM	CSI (C1)[b]	SPS	1/2
CSM	CDH (SR)[b]	SPS	2
CSM	TPI	SPS or SM RCS	1/4
CSM	TPF	SM RCS	1/3

[a]CSM rendezvous with a coelliptic Δh of 10 n. mi. above the LM and TPI one revolution later than nominal time.

[b]The printout maneuver terminology is given in parentheses.

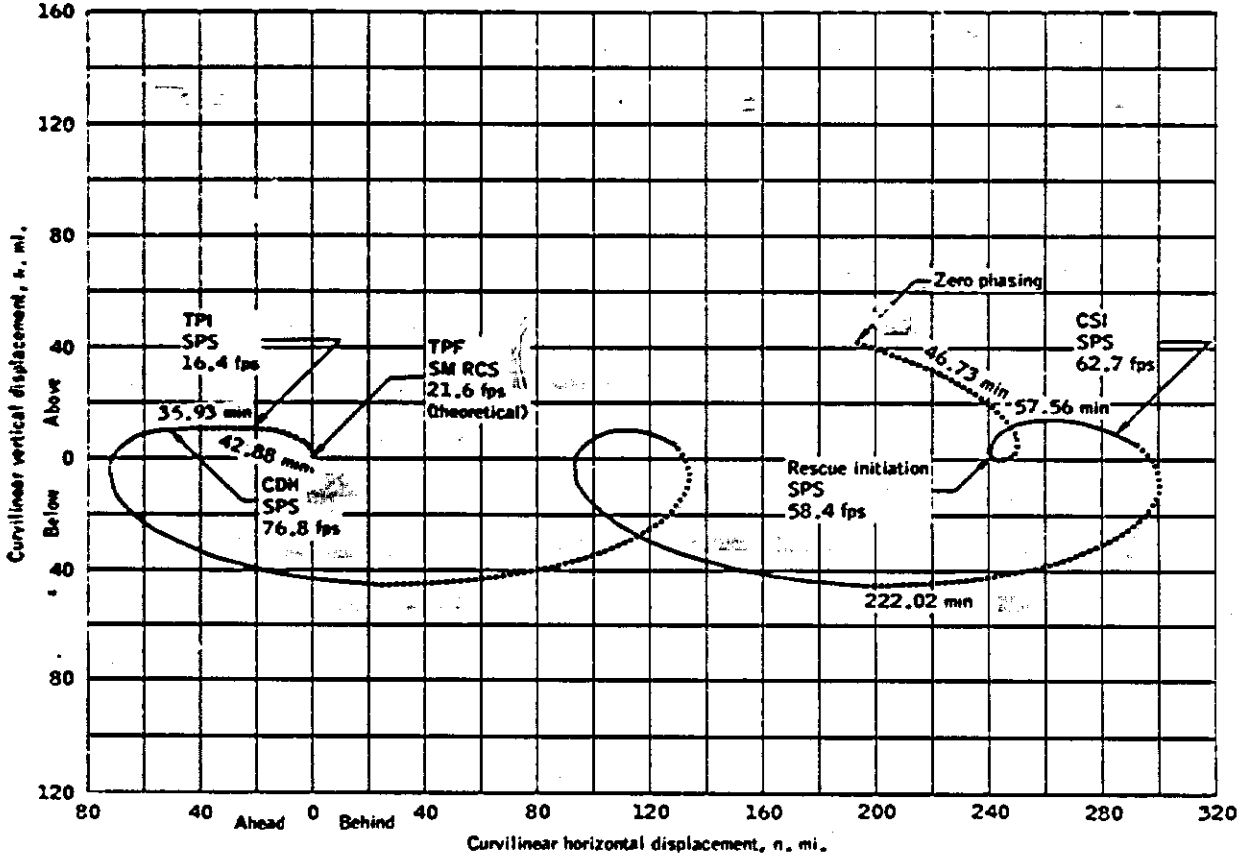
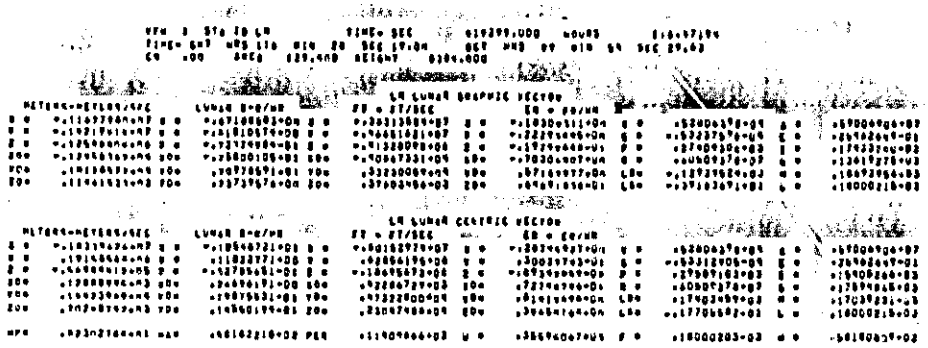


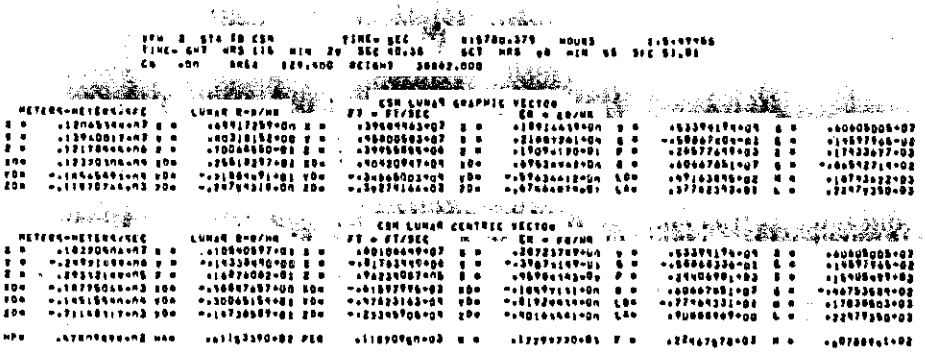
Figure 5.- Relative motion (curvilinear, LM-centered) for rescue after a zero phasing.

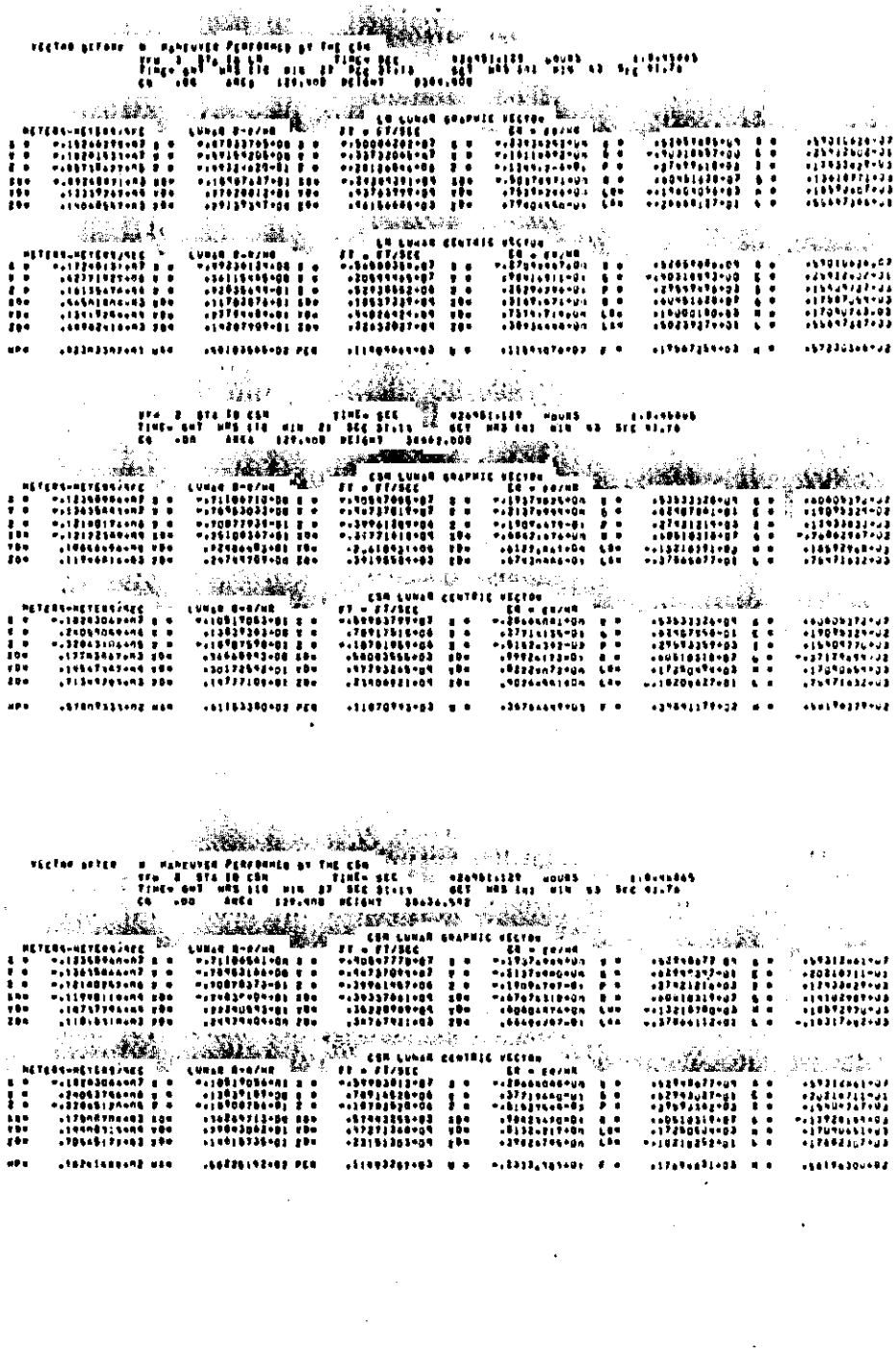
5.0 RESCUE AFTER A ZERO PHASING MANEUVER

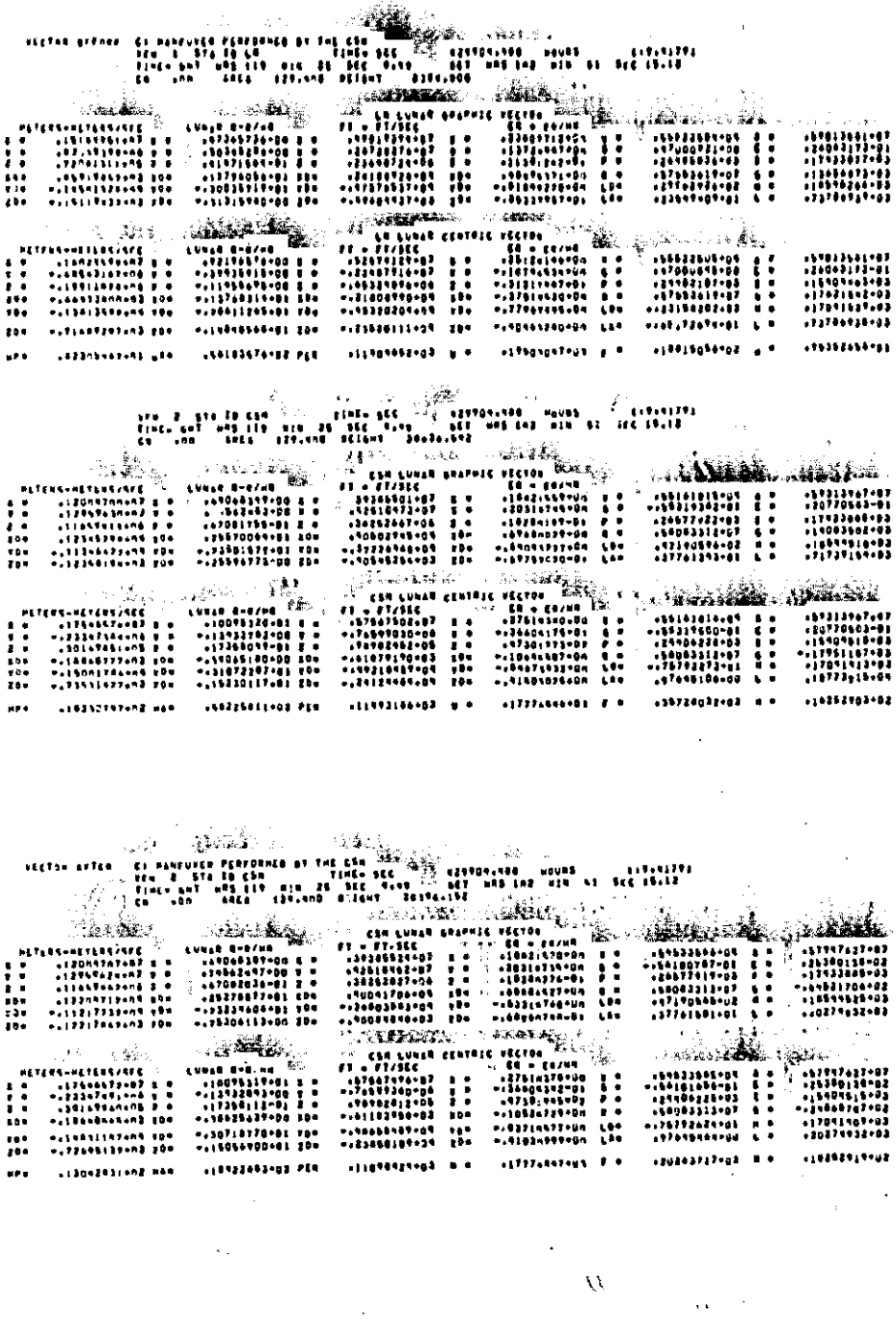
5.1 VECTORS

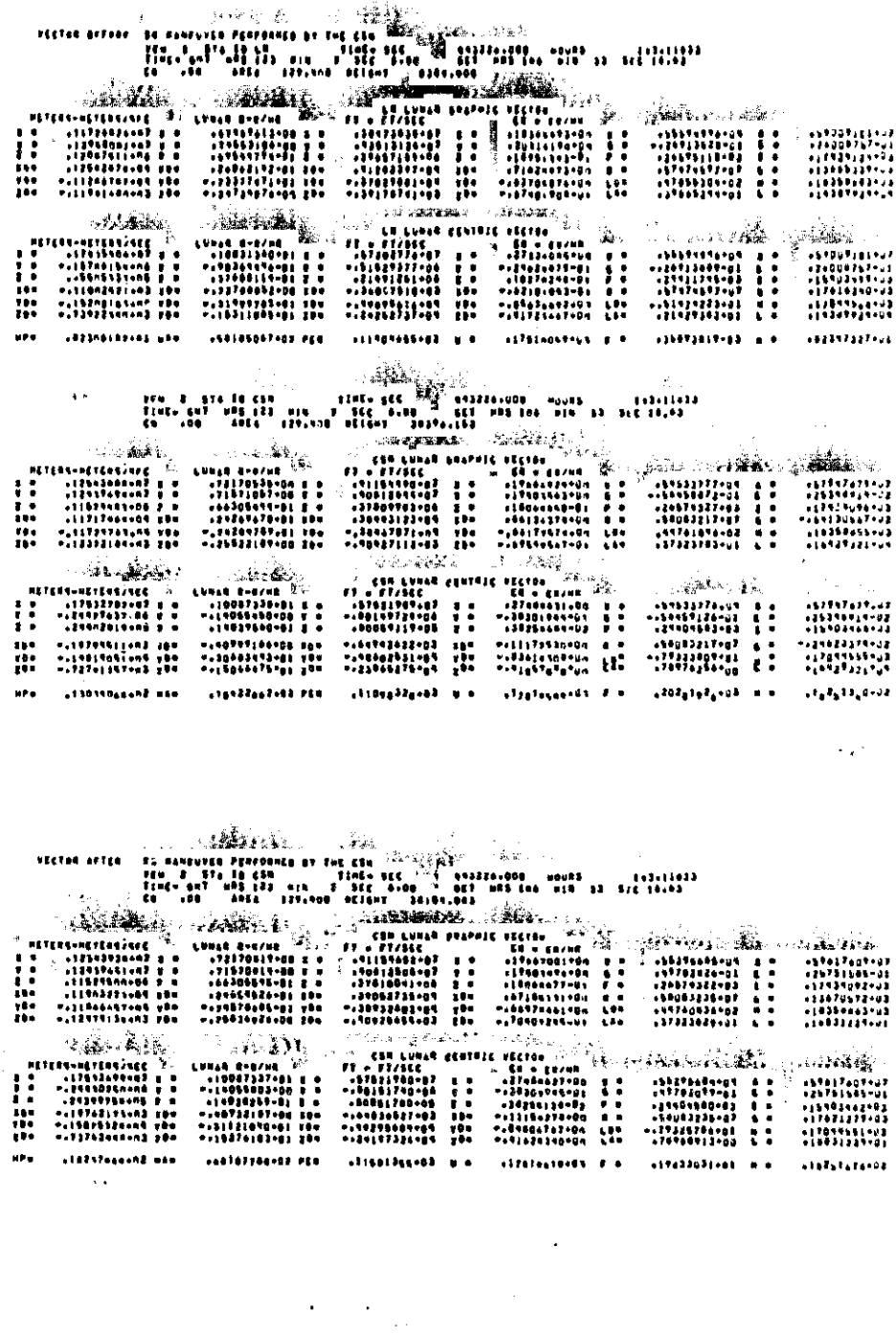
VECTORS THAT GENERATED THE FINAL PLAN THAT WAS SUBMITTED TO THE MPT

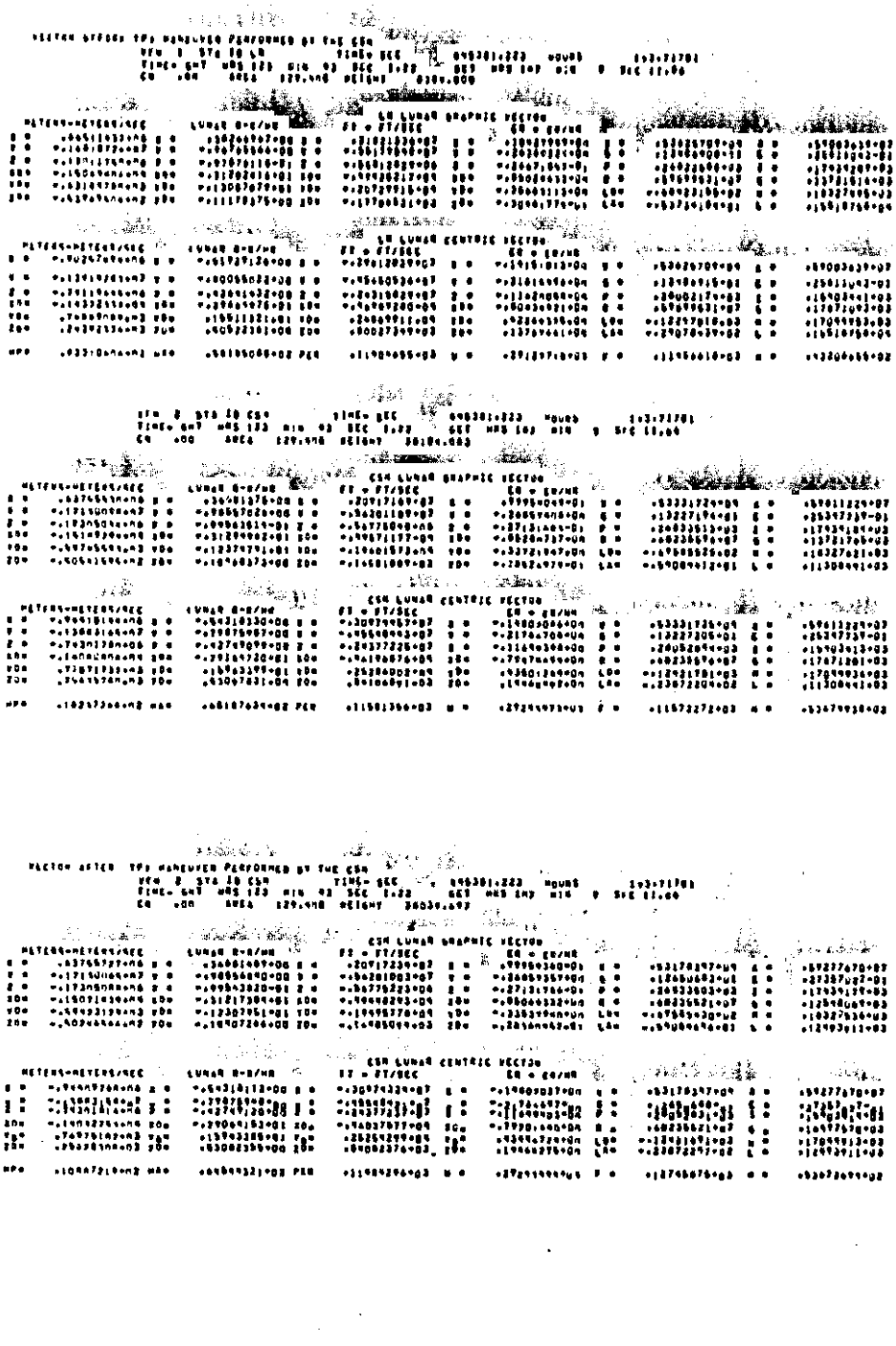


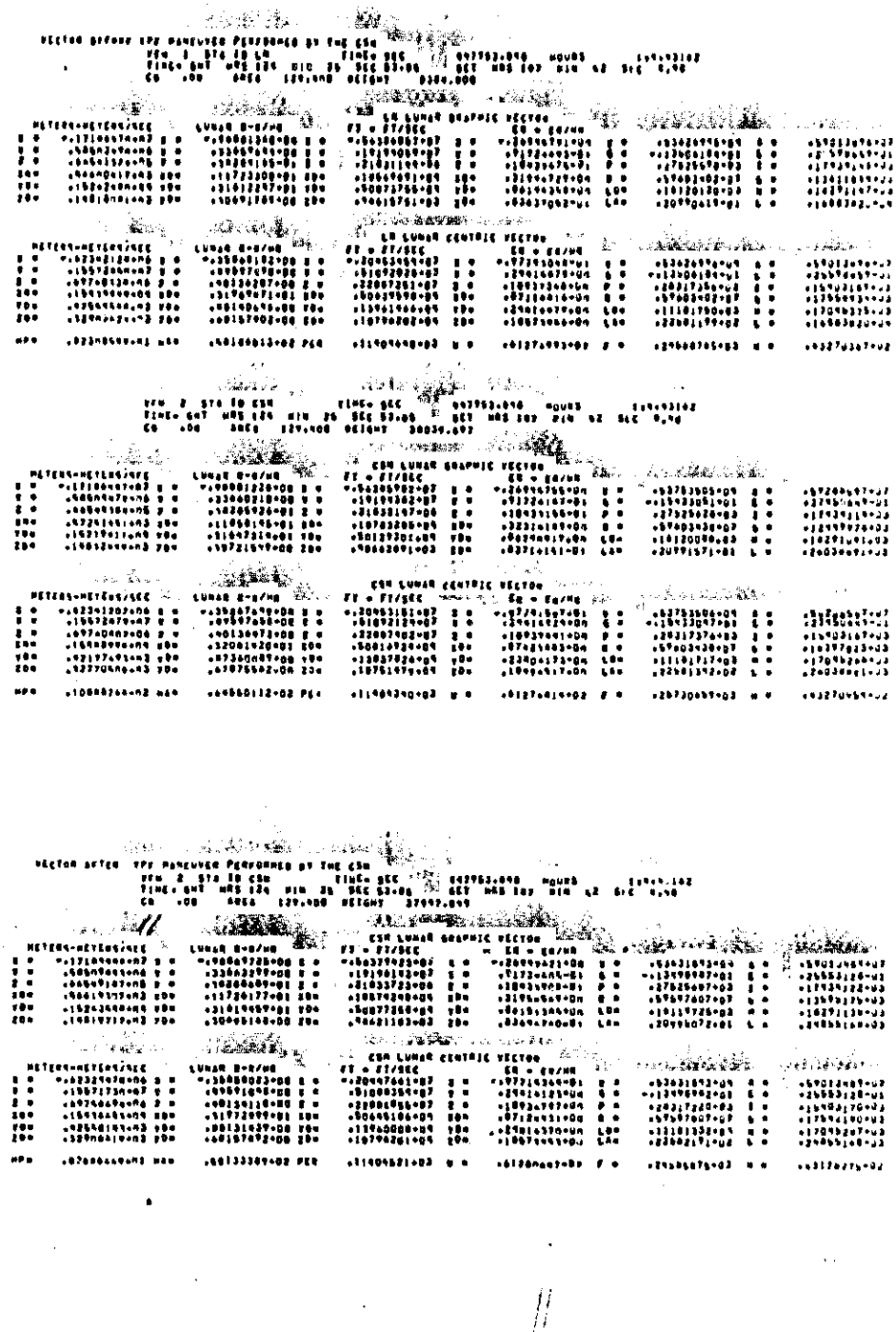






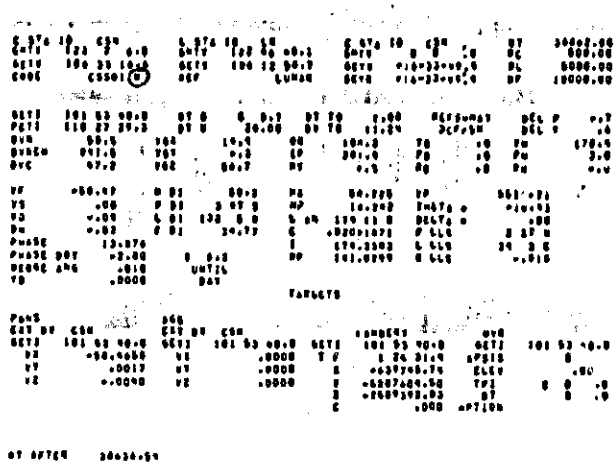




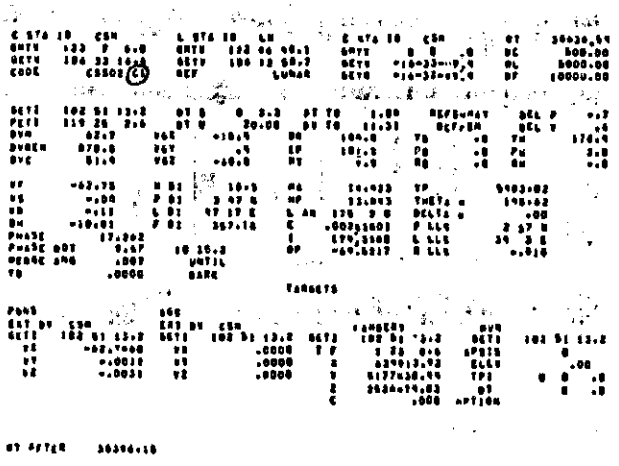


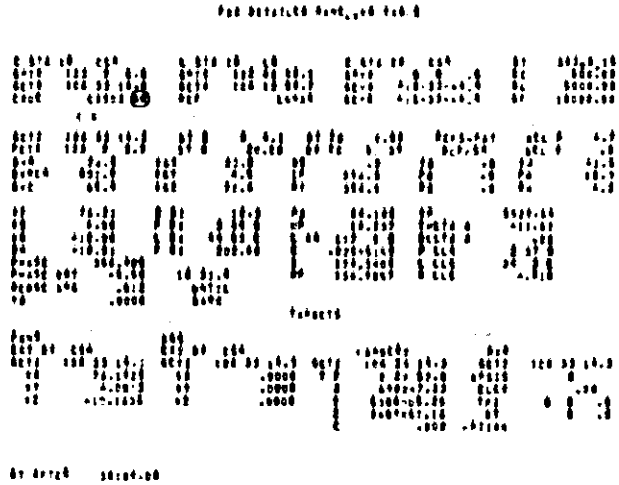
5.2 DETAILED MANEUVER TABLES

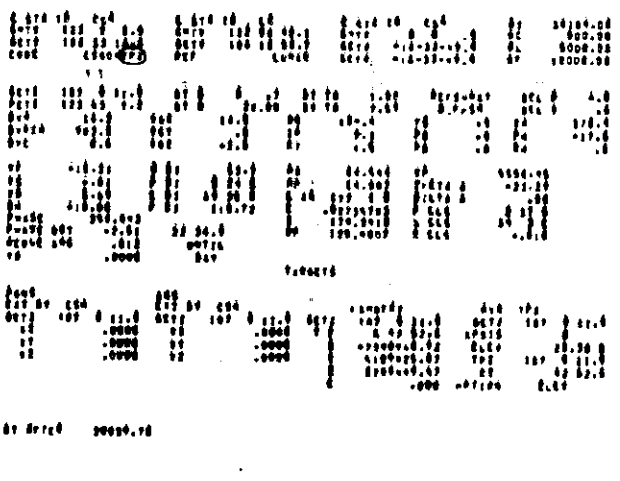
FOR DETAILED MANEUVER TABLE

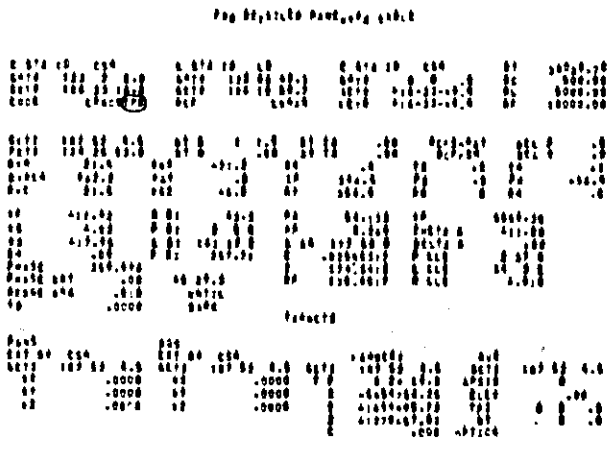


FOR DETAILED MANEUVER TABLE

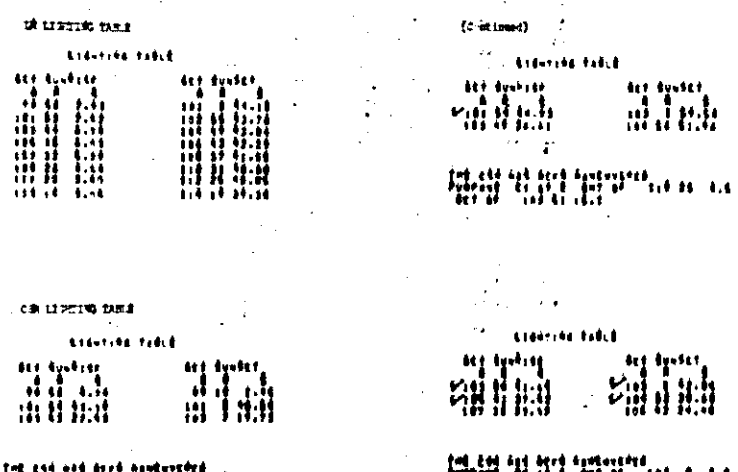








5.9 SUNRISE SUNSET TABLES



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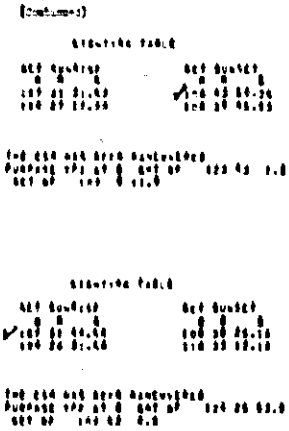

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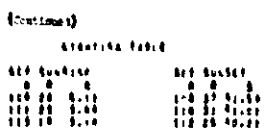
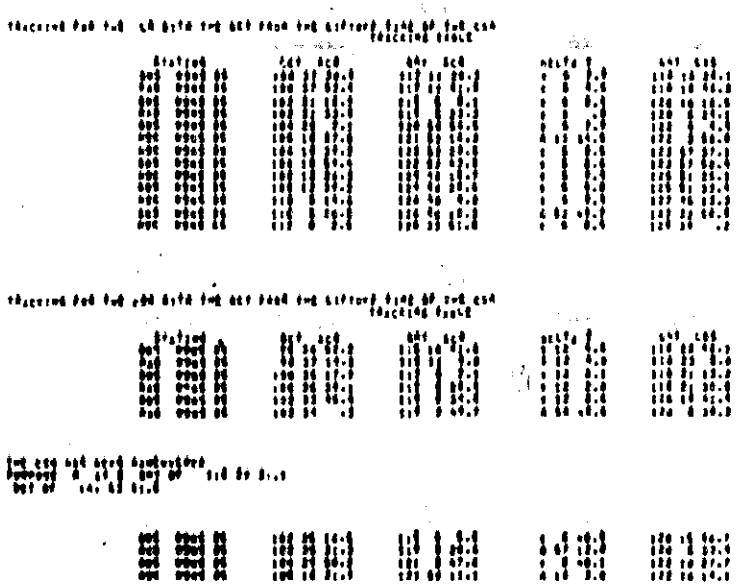


5.4 MSFN DEEP SPACE TRACKING



[illegible]

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6.0 RESCUE AFTER A PARTIAL PHASING MANEUVER OF 40 FPS

TABLE VI.- SUMMARY OF SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A PARTIAL PHASING MANEUVER OF 40 FPS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	Partial LM phasing (PHA)[b]	DPS (F.T.) and APS and RCS	2/3
CSM	Rescue initiation (R)[b]	SPS	1/3
CSM	CSI (CI)[b]	SPS	1/2
CSM	CDH (SR)[b]	SPS	1
LM	LM TPI	LM RCS	1/4
LM	LM TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI at the nominal time.

[b]The printout maneuver terminology is given in parentheses.

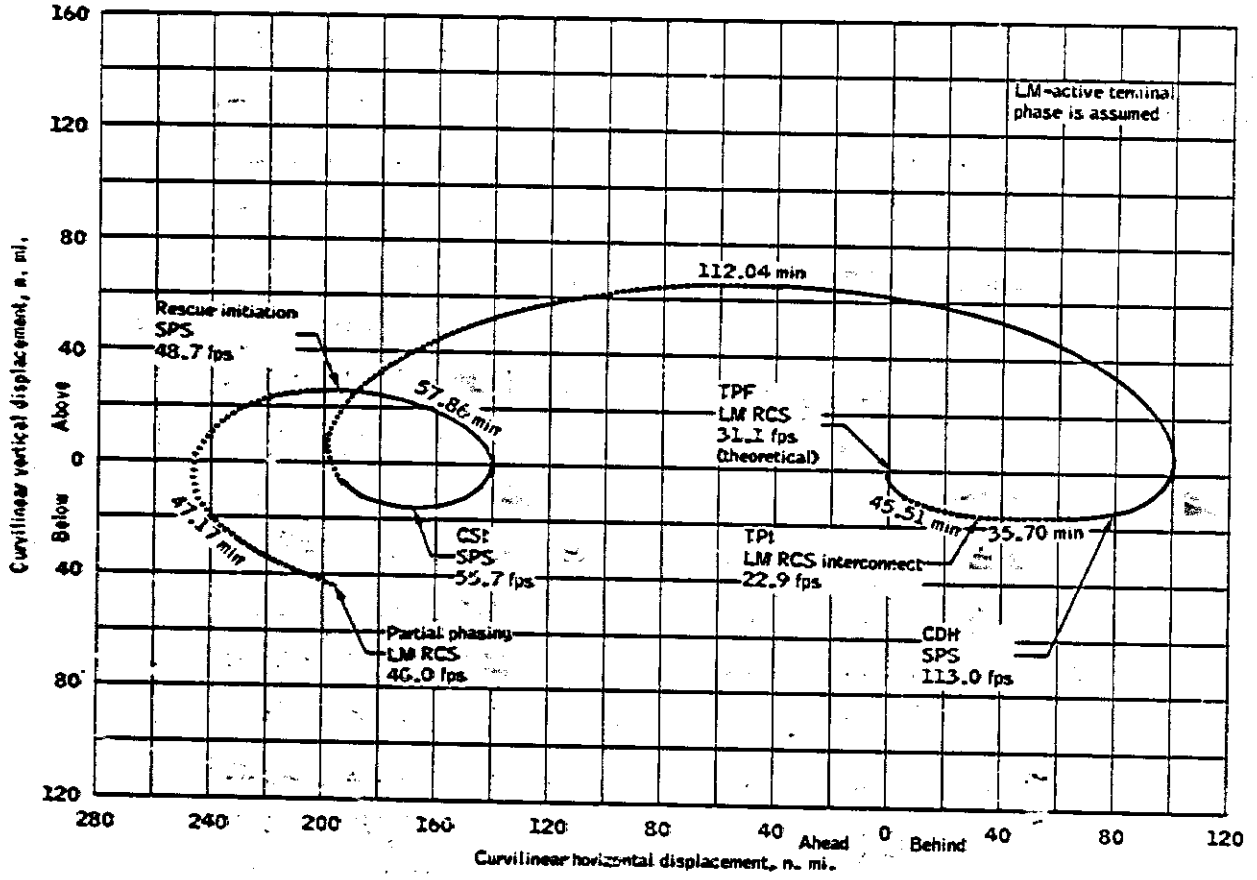
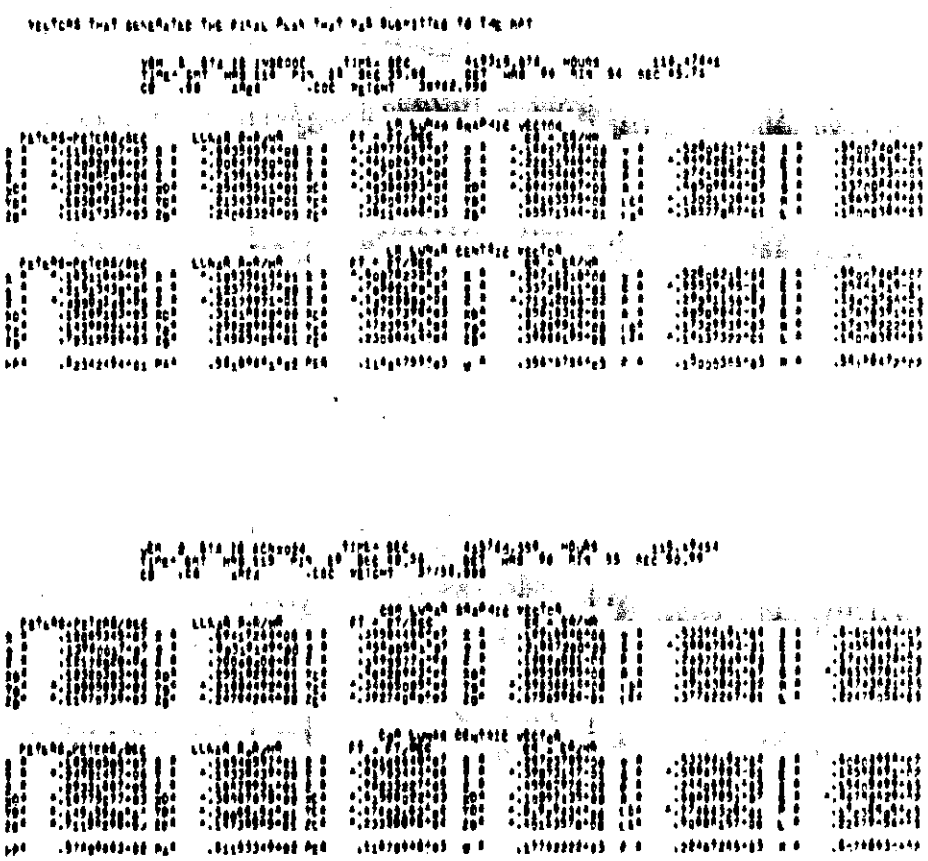
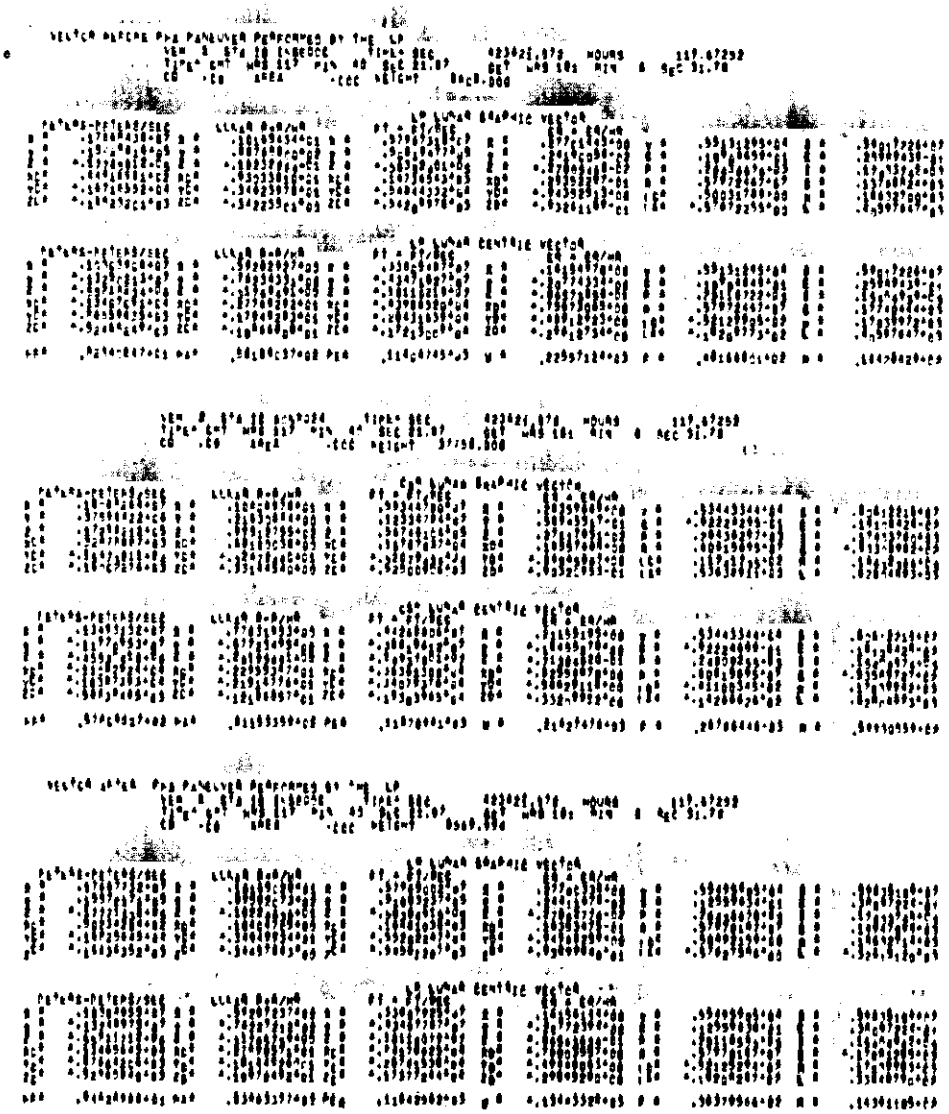


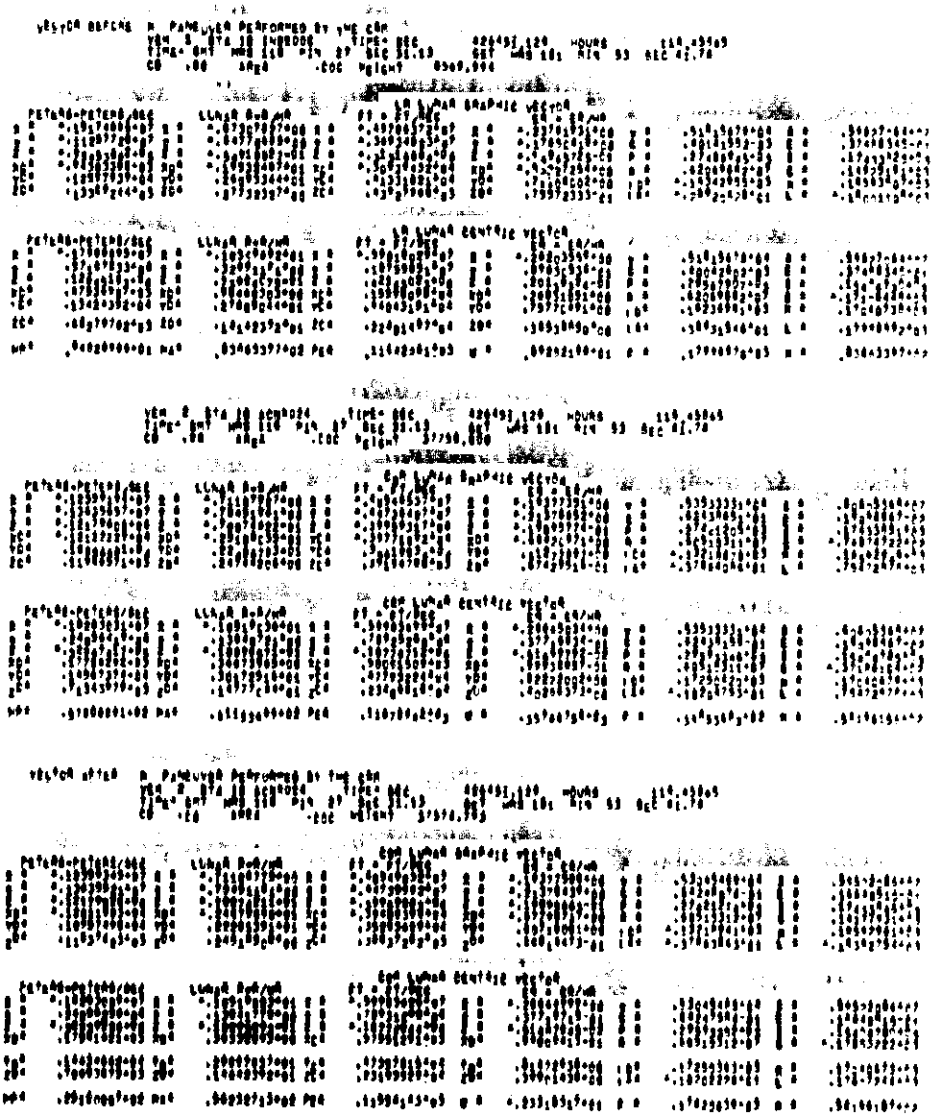
Figure 6.– Relative motion (curvilinear, CSM-centered) for rescue after partial phasing of 40 fps.

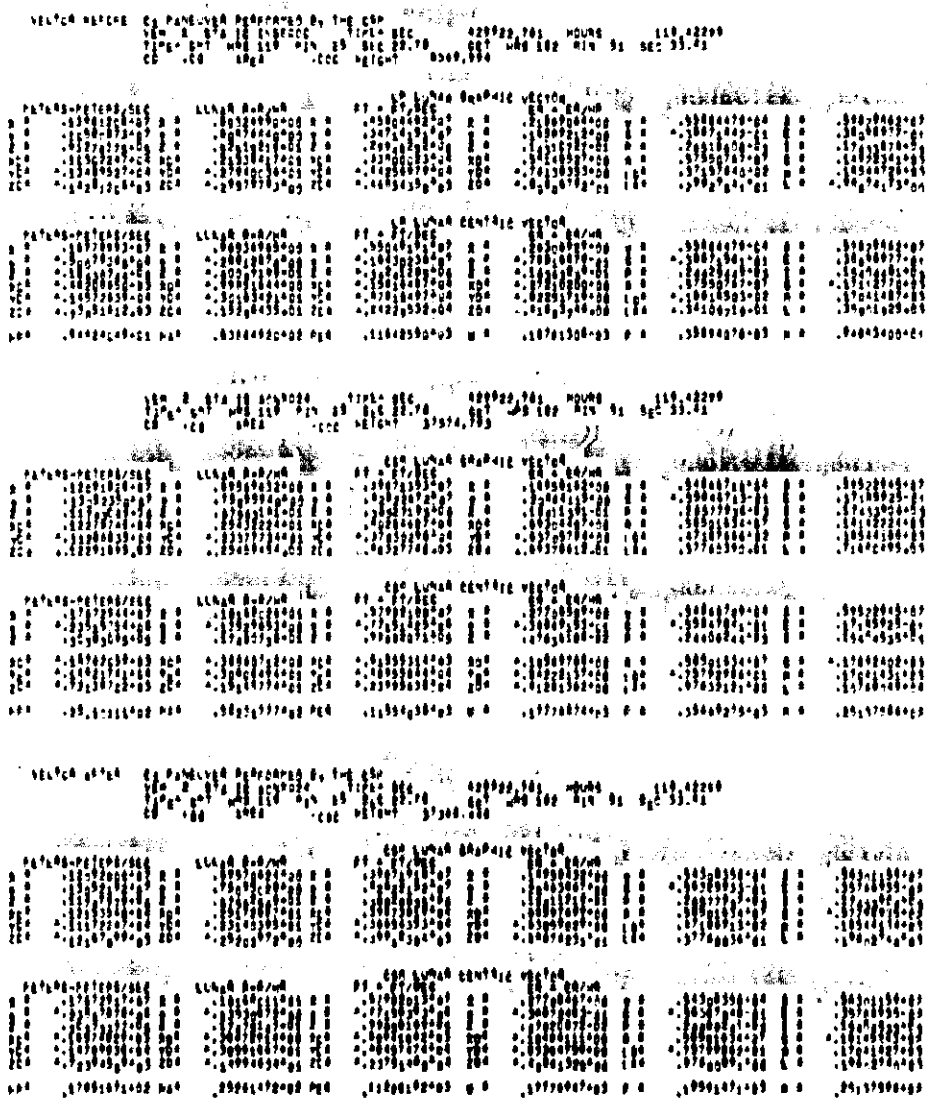
6.0 RESCUE AFTER A PARTIAL PHASING MANEUVER OF 40 FPS

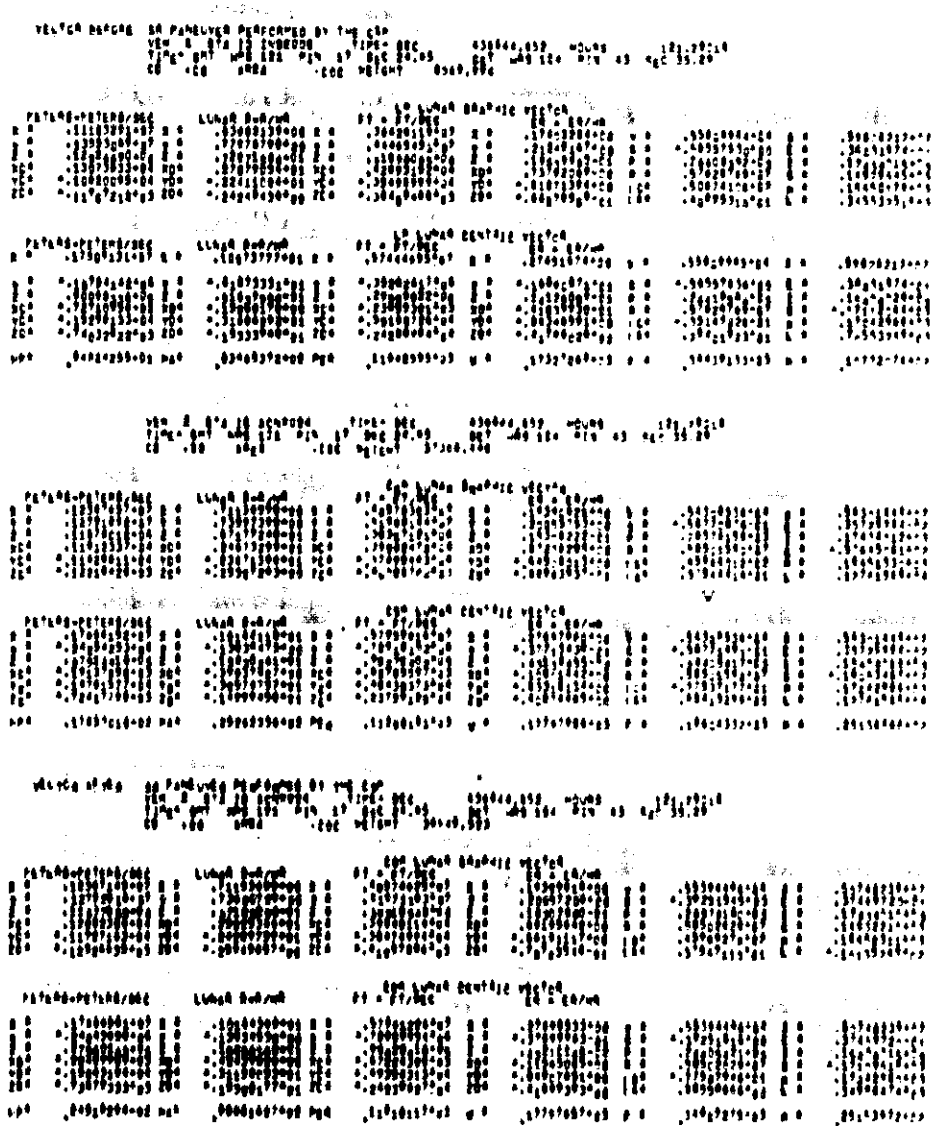
6.1 VECTORS

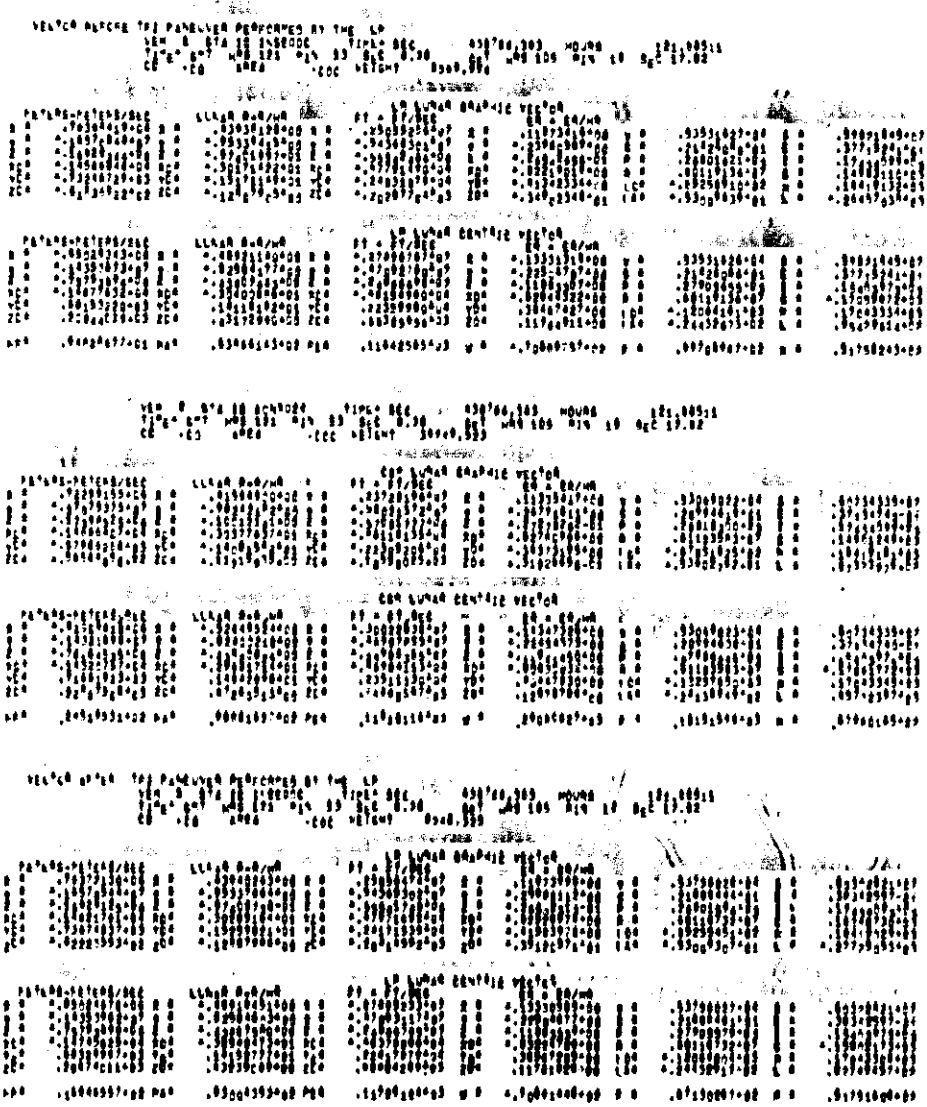




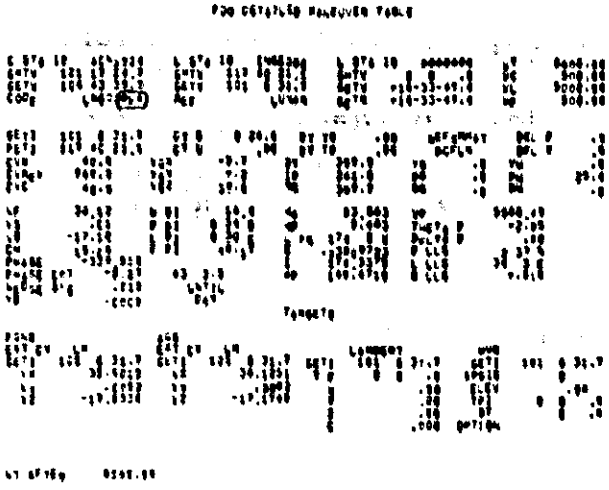


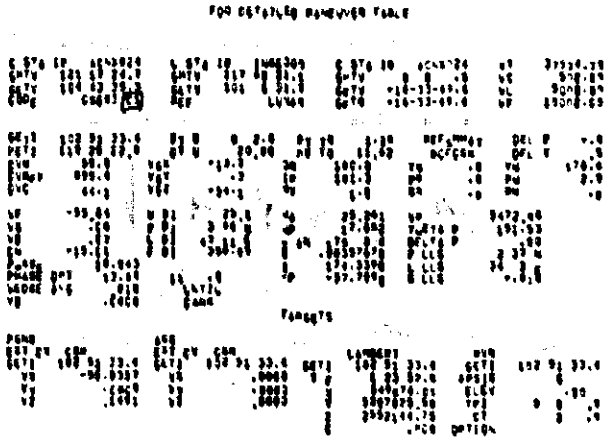


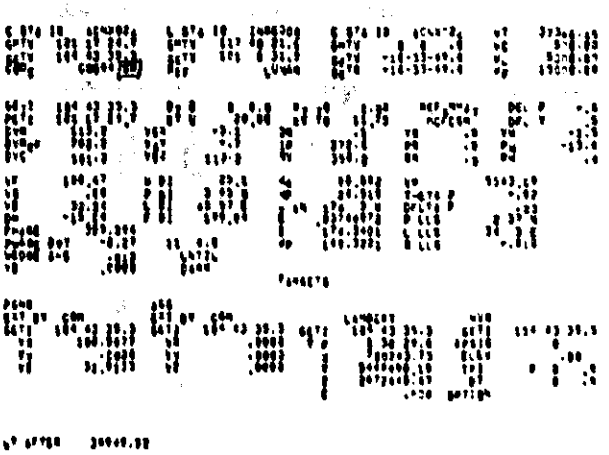


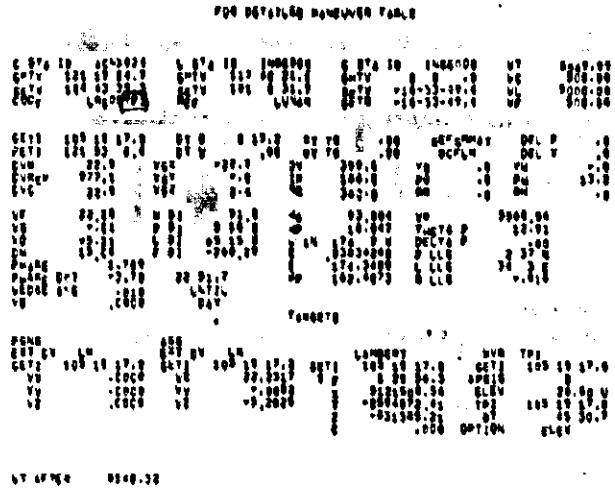


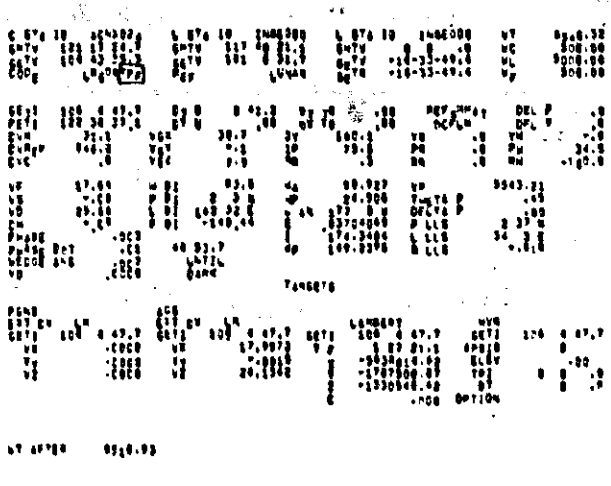
6.2 DETAILED MANEUVER TABLES











6.3 SUNRISE-SUNSET TABLES

LA LIGHTING TABLE

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 99	06	7.06	> 101	1	43.99
101	09	7.01	102	05	45.99

THE LP HAS BEEN PANELVERED
PURPOSE PHS AT A CNT OF 117 60 31.1
OUT OF 101 0 31.7

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 101	09	30.76	> 102	05	0.73
103	05	50.31	104	04	37.97
105	02	20.00	106	03	49.02
107	00	42.51	106	01	11.49
109	59	6.18	110	03	33.41

THE LP HAS BEEN PANELVERED
PURPOSE TPS AT A CNT OF 121 93 6.4
OUT OF 105 59 17.8

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 105	02	6.01	106	03	05.36
107	59	54.43	108	00	03.00

THE LP HAS BEEN PANELVERED
PURPOSE TPS AT A CNT OF 122 98 37.1
OUT OF 106 4 47.7

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 107	00	30.34	> 108	03	50.78
109	59	41.32	> 108	00	03.68

CSM LIGHTING TABLE

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 99	06	6.03	> 99	10	3.43
101	04	43.37	> 101	9	40.57
103	03	22.91	103	7	19.71

THE CSM HAS BEEN PANELVERED
PURPOSE N AT A CNT OF 110 87 31.1
OUT OF 101 93 42.6

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 101	04	44.30	103	2	57.94
103	03	22.97	104	00	36.09

THE CSM HAS BEEN PANELVERED
PURPOSE CS AT A CNT OF 119 85 22.8
OUT OF 102 91 33.6

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
103	01	2.09	> 103	2	44.29
105	02	58.57	104	00	41.12

THE CSM HAS BEEN PANELVERED
PURPOSE SR AT A CNT OF 121 87 24.7
OUT OF 104 43 35.3

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
	H	M		H	M
> 105	01	55.76	> 104	04	47.84
> 107	00	38.34	> 106	03	52.76
> 109	59	45.98	> 108	02	53.39
> 111	58	43.01	> 110	01	56.29

6.4 MSFN DEEP-SPACE TRACKING

TRACKING FOR THE LM WITH THE GET FROM THE LIFTOFF TIME OF THE CSM
TRACKING TABLE

STATION	GET	ACQ	GMT	ACQ	DELTA T	GMT	LOS
GDS LS85 85	102 22 30.3		117 11 57.4		1 8 6.8	118 00 27.4
PAD LS85 85	102 22 54.6		117 11 [illegible]		1 8 [illegible]	118 00 [illegible]
GDS LS85 85	102 23 [illegible]		117 11 [illegible]		1 8 [illegible]	118 00 [illegible]
PAD LS85 85	102 23 33.9		117 11 [illegible]		1 8 [illegible]	118 00 [illegible]

THE LM HAS BEEN MANEUVERED
PURPOSE PHA AT A GMT OF 117 40 25.8
GET OF 101 8 35.9

GDS	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
PAD	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
GDS	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
PAD	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
GDS	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
HSK	LS85 85	103 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
HSK	LS85 85	103 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
GDS	LS85 85	103 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
HSK	LS85 85	103 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]
GDS	LS85 85	103 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]

THE LM HAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 121 93 6.4
GET OF 103 19 17.8

GDS	LS85 85	104 17 3.4		121 8 52.7		1 8 49.3	122 18 33.6
HSK	LS85 85	104 18 23.6		121 52 13.2		1 33 [illegible]	122 [illegible]
HSK	LS85 85	104 24 23.7		122 38 [illegible]		1 9 [illegible]	124 [illegible]
GDS	LS85 85	104 24 37.7		122 38 [illegible]		1 9 [illegible]	124 [illegible]

THE LM HAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 122 38 37.5
GET OF 104 4 47.7

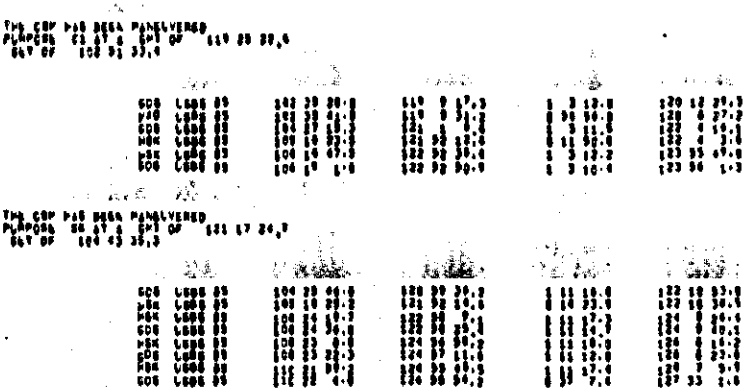
HSK	LS85 85	104 24 19.7		122 38 [illegible]		1 11 17.8	124 [illegible]
GDS	LS85 85	104 24 34.6		122 38 [illegible]		1 11 [illegible]	124 [illegible]
HSK	LS85 85	104 [illegible]		122 [illegible]		1 11 [illegible]	124 [illegible]
GDS	LS85 85	104 [illegible]		122 [illegible]		1 11 [illegible]	124 [illegible]

TRACKING FOR THE CSM WITH THE GET FROM THE LIFTOFF TIME OF THE CSM
TRACKING TABLE

STATION	GET	ACQ	GMT	ACQ	DELTA T	GMT	LOS
GDS LS85 85	98 36 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
PAD LS85 85	98 37 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
GDS LS85 85	98 37 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
PAD LS85 85	98 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
GDS LS85 85	98 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
PAD LS85 85	98 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
GDS LS85 85	98 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]
HSK LS85 85	98 [illegible]		113 [illegible]		1 12 [illegible]	114 [illegible]

THE CSM HAS BEEN MANEUVERED
PURPOSE H AT A GMT OF 114 27 31.3
GET OF 101 53 41.8

GDS	LS85 85	102 34 [illegible]		117 8 [illegible]		1 9 [illegible]	118 [illegible]
PAD	LS85 85	102 35 [illegible]		117 9 [illegible]		0 57 [illegible]	118 [illegible]
GDS	LS85 85	102 [illegible]		117 [illegible]		1 9 [illegible]	118 [illegible]
HSK	LS85 85	102 [illegible]		117 [illegible]		1 [illegible]	118 [illegible]



7.0 RESCUE AFTER A PARTIAL PHASING MANEUVER OF 160 FPS

TABLE VII.- SUMMARY OF SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A PARTIAL PHASING MANEUVER OF 160 FPS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	Partial LM phasing (PHA)[b]	DPS (F.T.) and APS	2/3
CSM	Rescue initiation (H)[b]	SPS	1/3
CSM	CSI (C1)[b]	SPS	1/2
CSM	CDH (SR)[b]	SPS	1
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI at the nominal time.

[b]The printout maneuver terminology is given in parentheses.

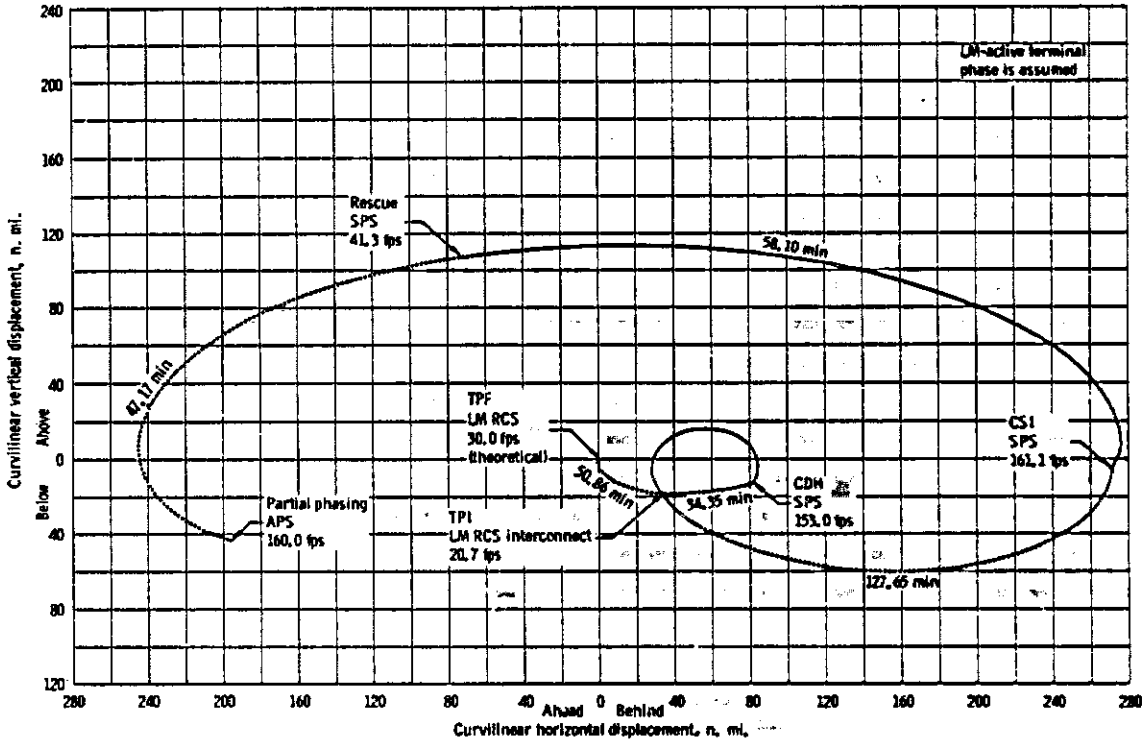
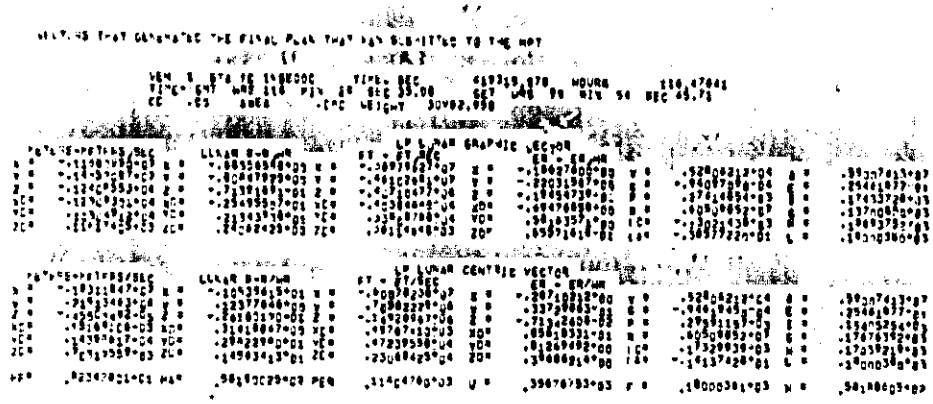
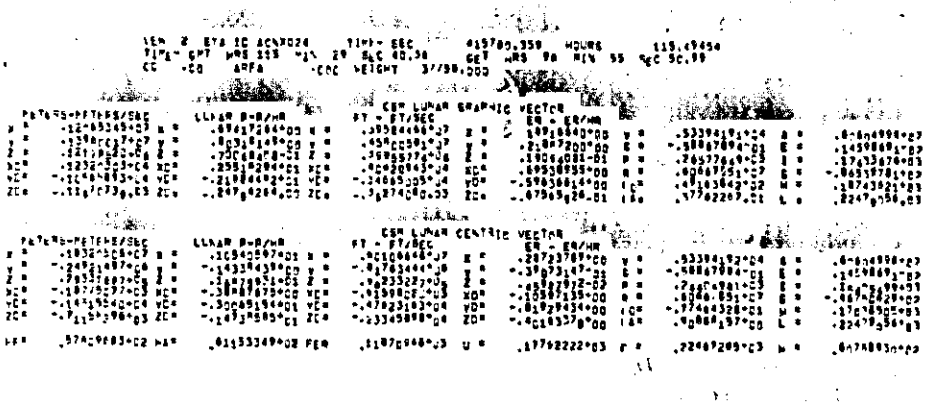


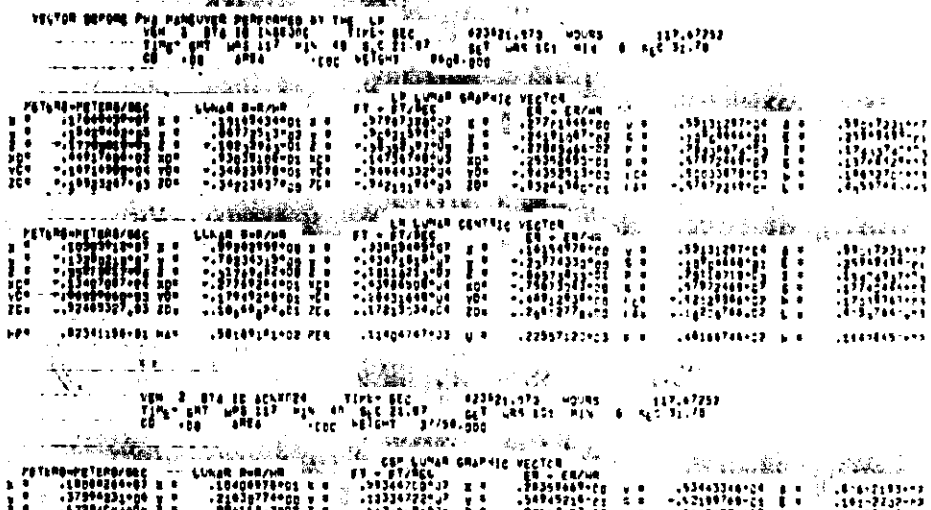
Figure 7.- Relative motion (curvilinear, CSM-centered) for rescue after partial phasing of 160 fps.

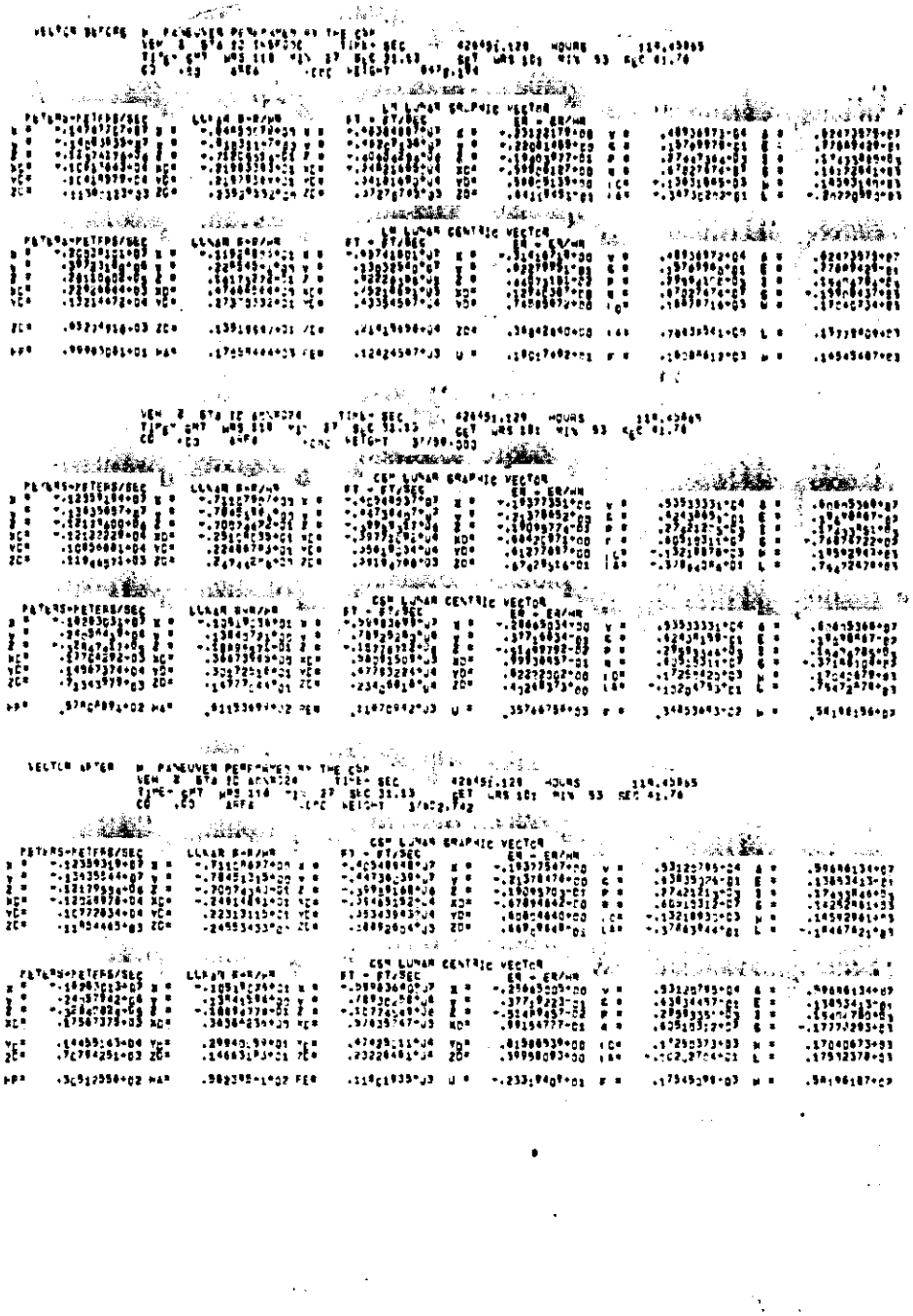
7.0 RESCUE AFTER A PARTIAL PHASING MANEUVER OF 160 FPS

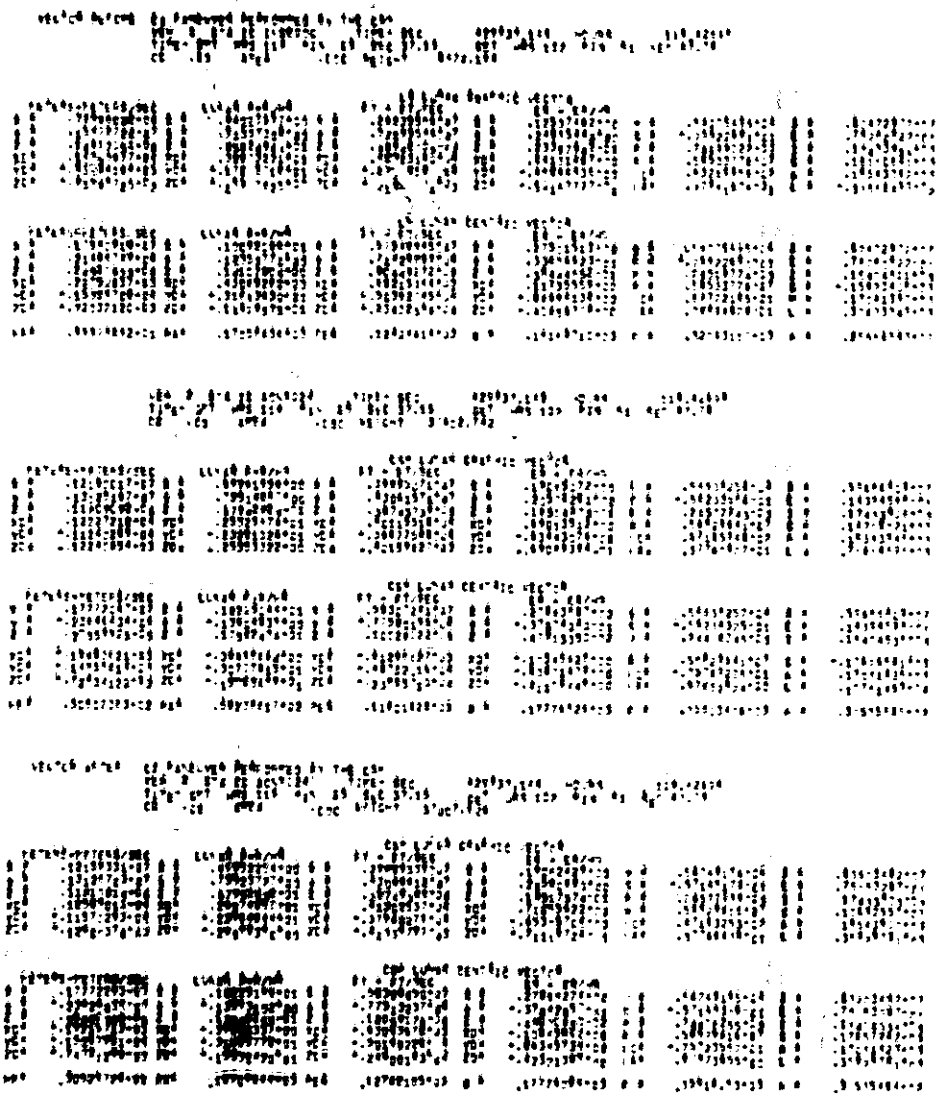
7.1 VECTORS

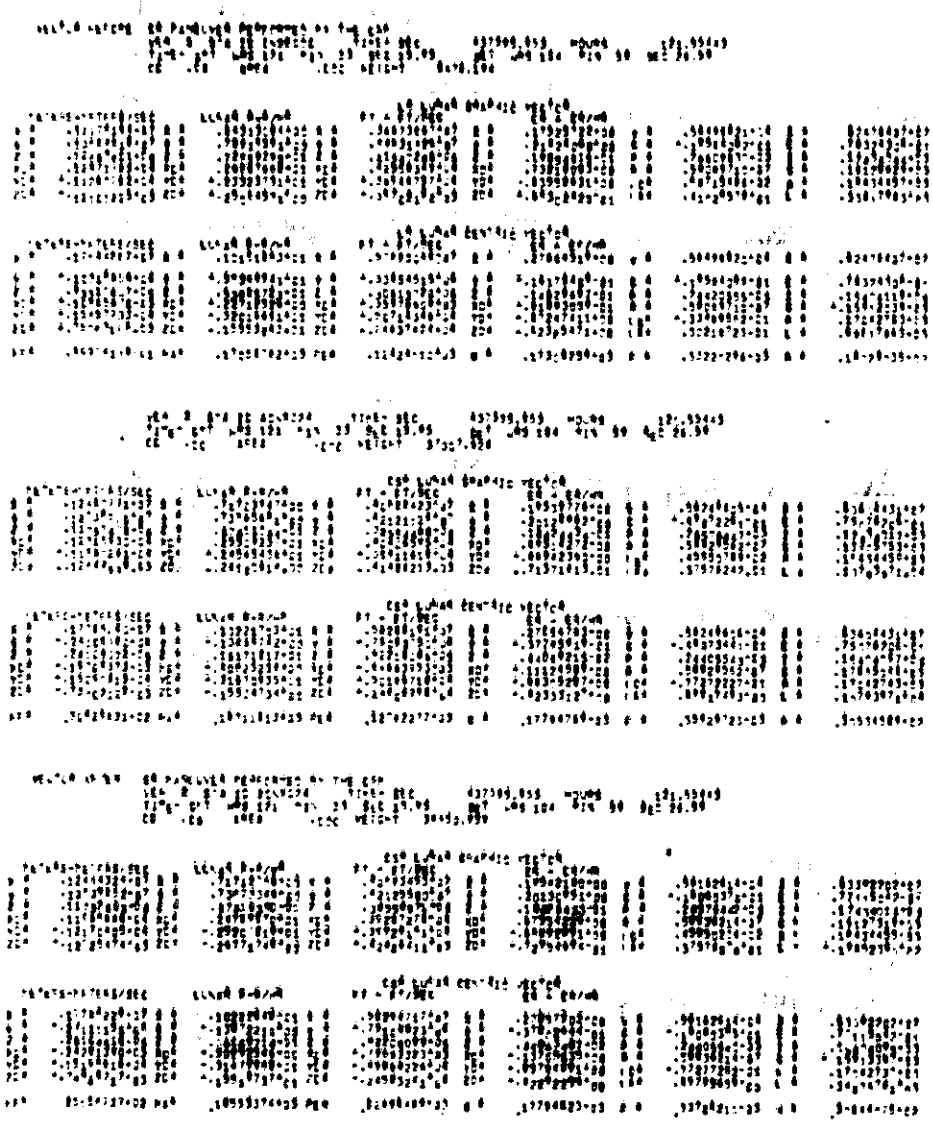


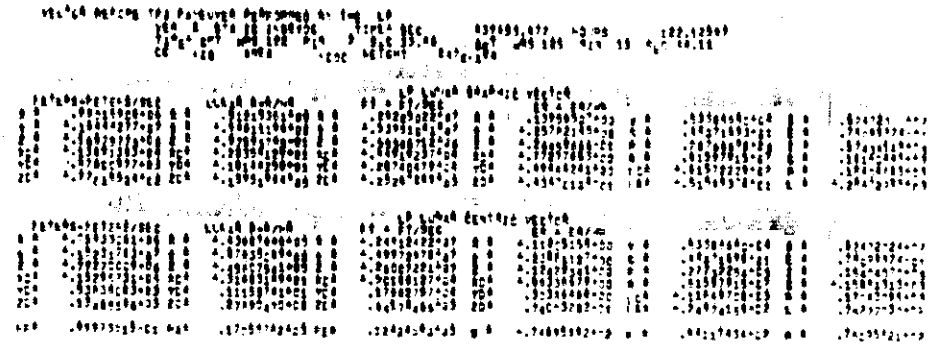


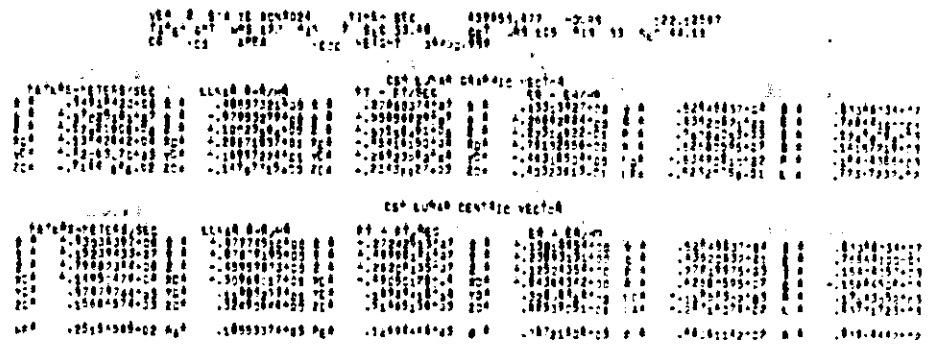


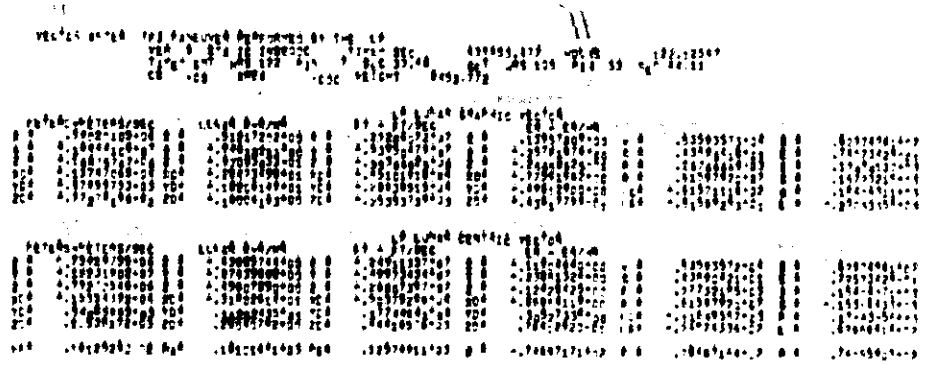


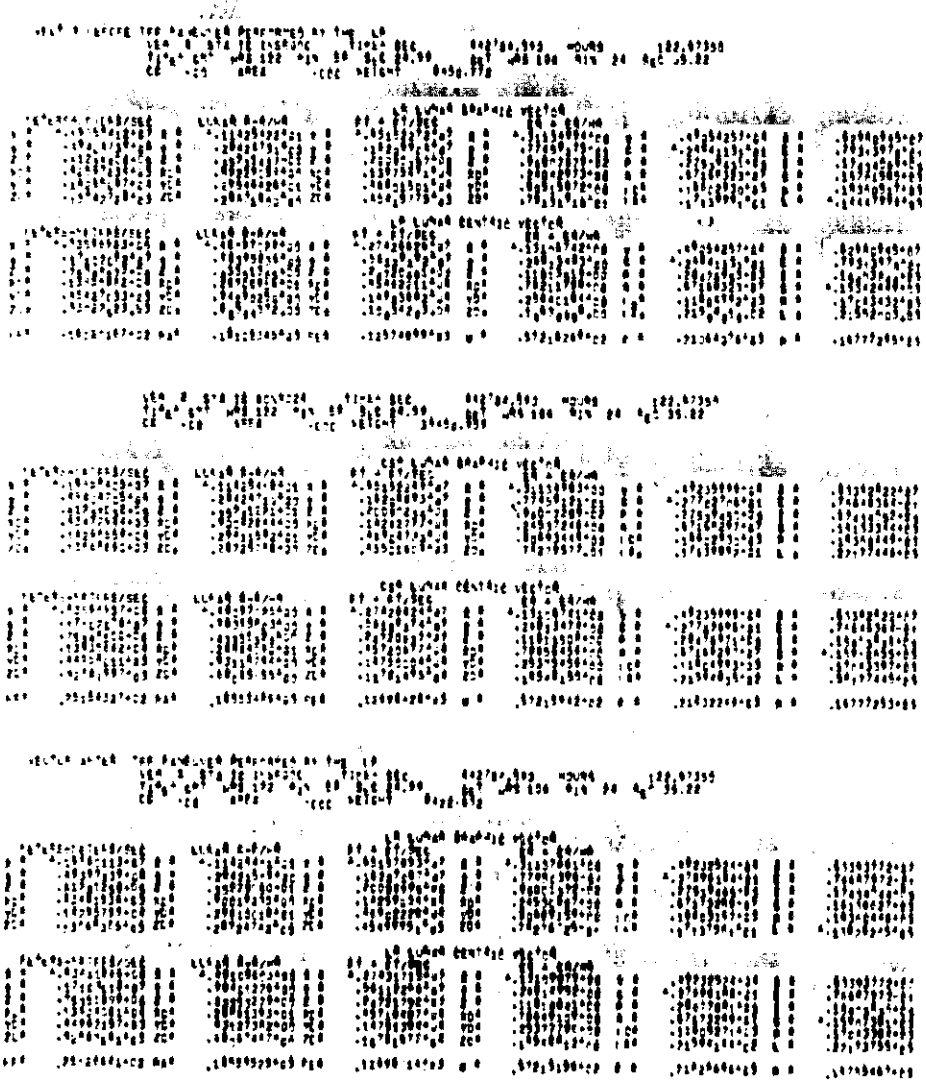




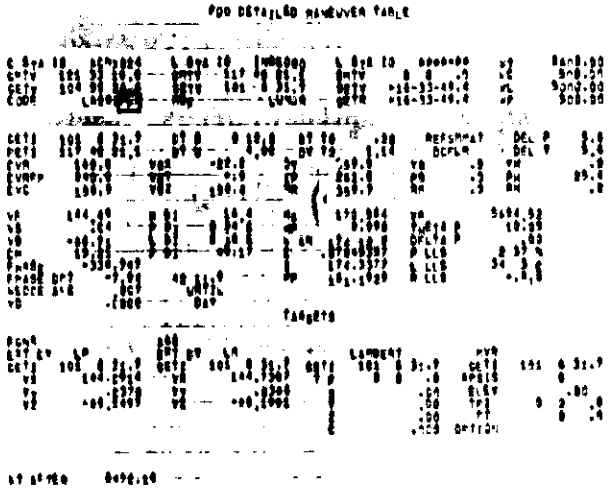


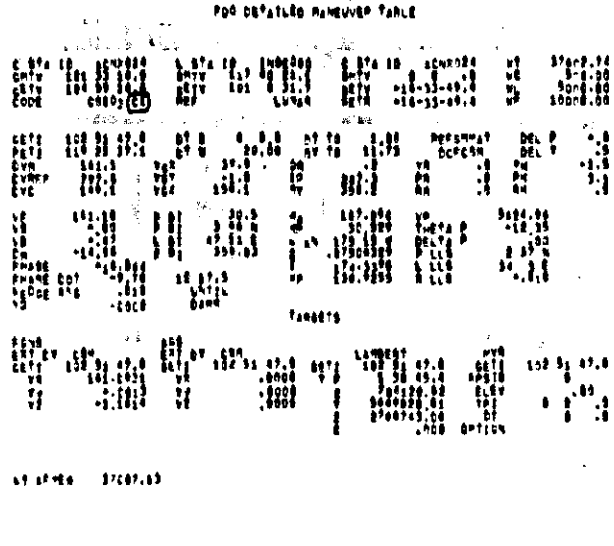




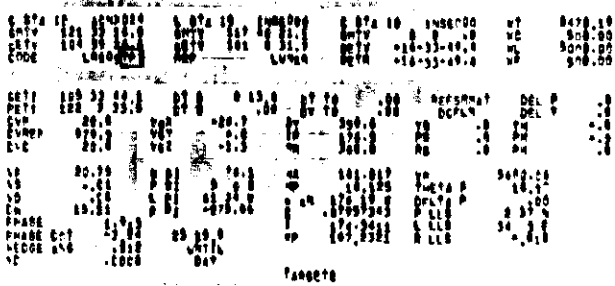


7.2 DETAILED MANEUVER TABLES

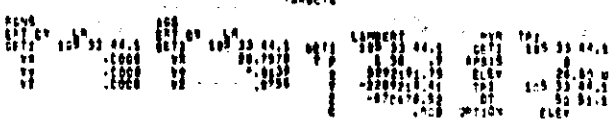



POD DETAILED MANEUVER TABLE
TARGETS
POD DETAILED MANEUVER TABLE
TARGETS

PD8 DETAILED MANEUVER TABLE

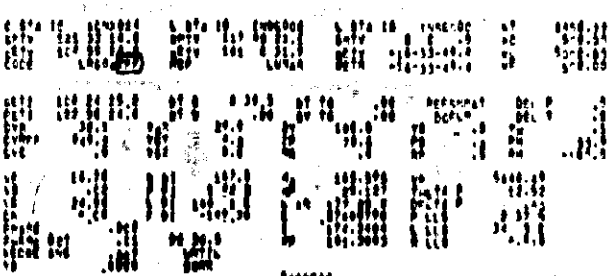


TARGETS

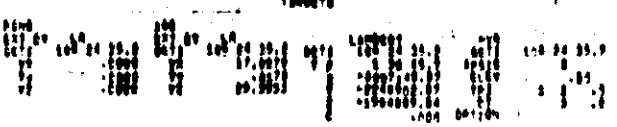


AT AFTER 0496.99

PD8 DETAILED MANEUVER TABLE

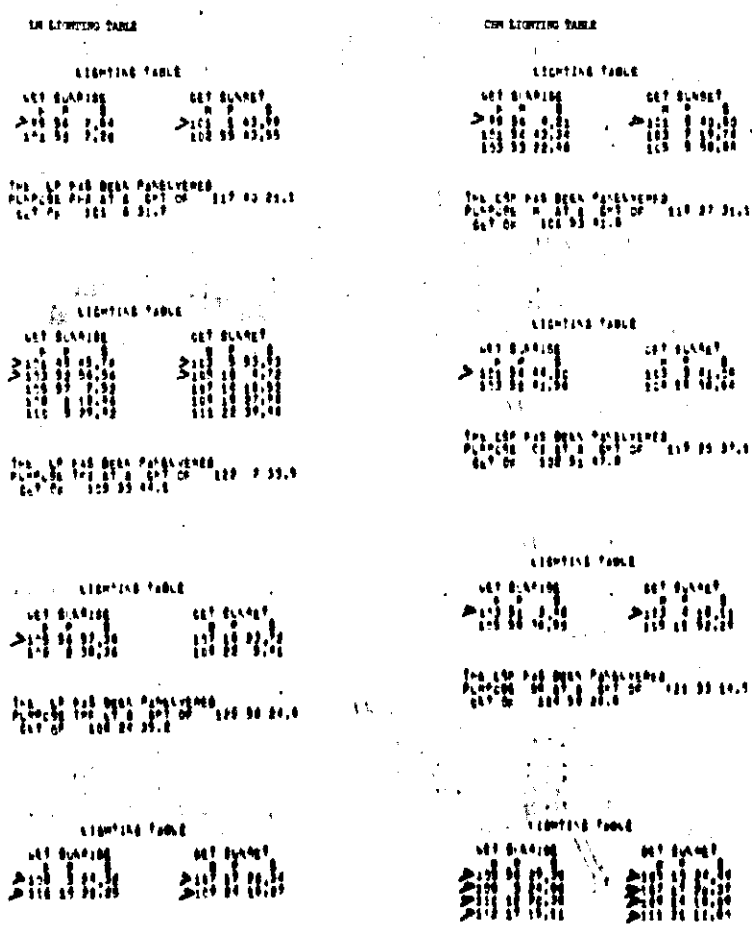


TARGETS

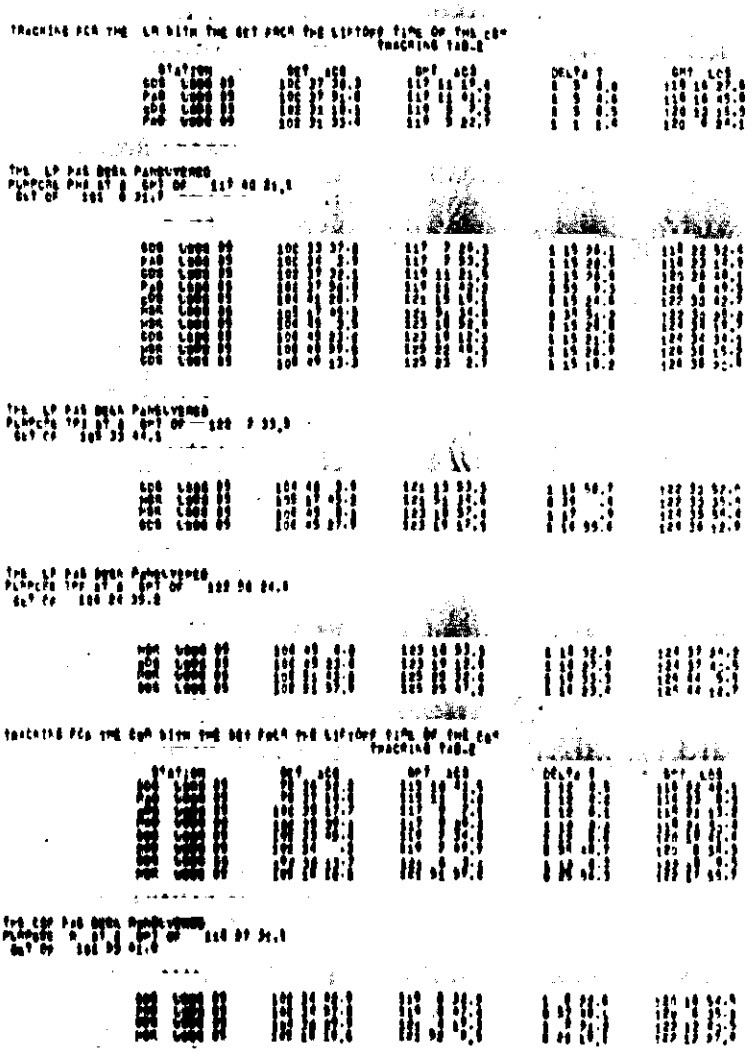


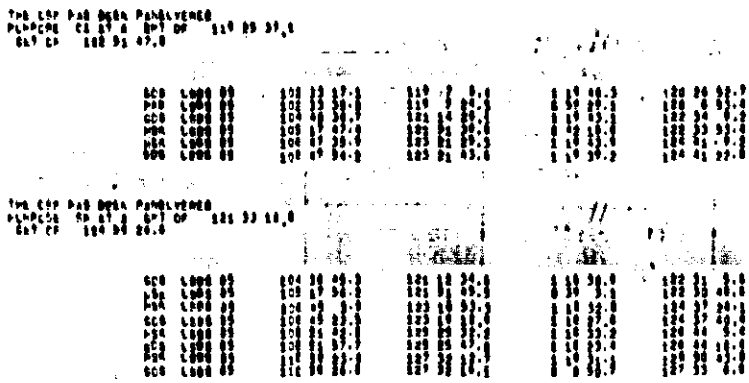
AT AFTER 0498.66

7.3 SUNRISE-SUNSET TABLES



7.4 MSFN DEEP-SPACE TRACKING





UNCLASSIFIED

8.0 RESCUE AFTER A ZERO INSERTION MANEUVER

TABLE VIII.- SUMMARY OF SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A ZERO INSERTION MANEUVER[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
CSM	CSM insertion (FCT)[b]	SPS	5/6
CSM	CSI	SPS	1/2
CSM	CDH	SPS	1/2
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI at the nominal time.

[b]The printout maneuver terminology is given in parentheses.

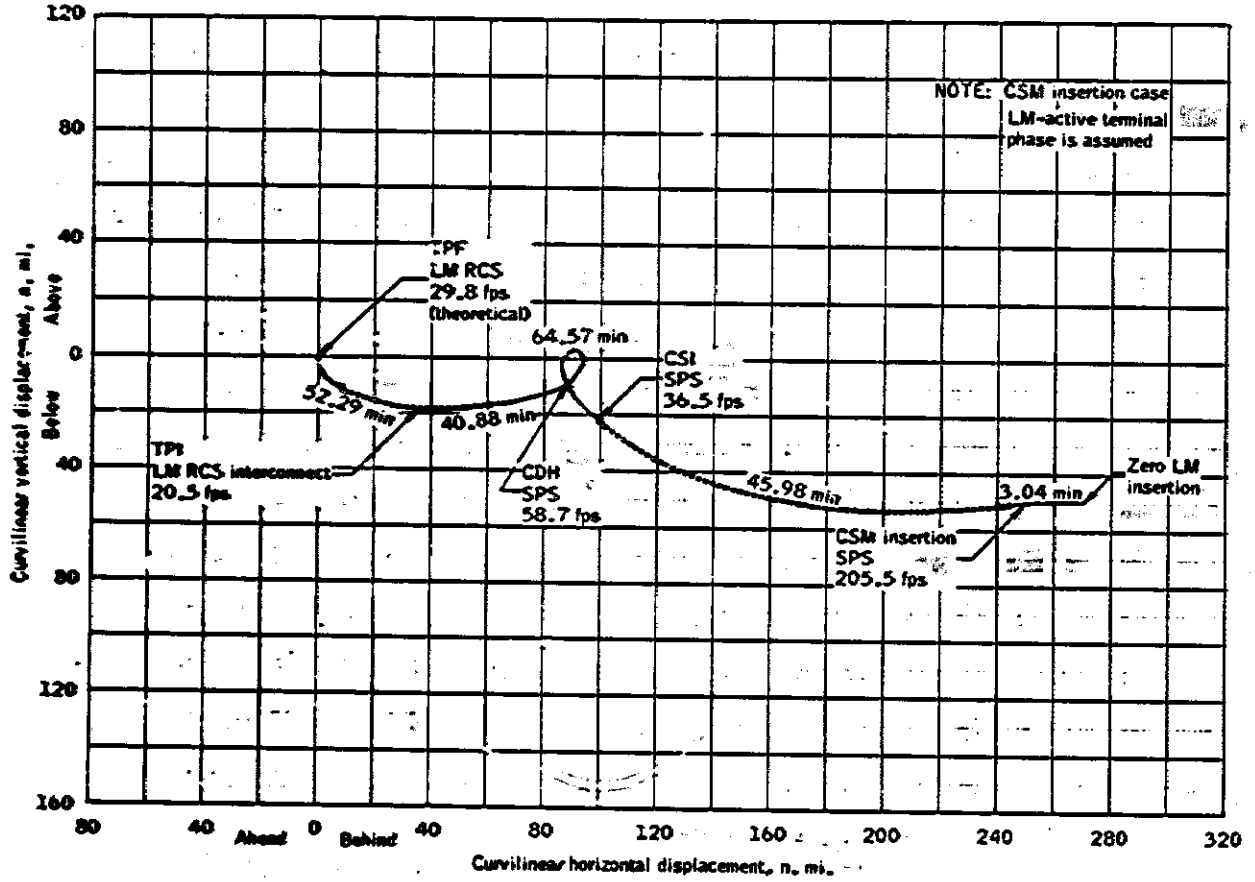


Figure 8.– Relative motion (curvilinear, CSM-centered) for rescue after zero LM insertion.

8.0 RESCUE AFTER A ZERO INSERTION MANEUVER

8.1 VECTORS

VECTORS THAT GENERATED THE FINAL PLAN THAT WAS SUBMITTED TO THE MPT

VEH 3 STA ID LM TIME- SEC 423994.944 HOURS 117.66192
TIME- GMT HRS 113 MIN 40 SEC 39.97 GET HRS 101 MIN 7 SEC 9.28
CD .00 AREA .000 WEIGHT 33375.00

LM LUNAR GRAPHIC VECTOR

	PETRO-PETERS/SEC	LUNAR R-R/HR	PT - PT/SEC	EQ - EQ/HR	
X =	-.1214003E+07	X = -.1911E+06	X = -.7221E+03	V =	.5833152E+04
Y =	-.1806E+07	Y = -.2838E+06	Y = -.1072E+04	S =	.1973E+04
Z =	-.8326E+06	Z = -.1309E+06	Z = -.4945E+03	P =	.2843E+03
XD=	.1793E+02	XD= .2819E+01	XD= .1065E-01	A =	.5900E+04
YD=	-.7E+06	YD= -.1E+06	YD= .3039E+04	LO=	-.1E+07
ZD=	-.2700E+07	ZD= -.4E+06	ZD= .9578E+04	LA=	-.1E+07

					.5833152E+04
					.1973E+04
					.2843E+03
					.5900E+04
					-.1E+07
					-.1E+07

LM LUNAR CENTRIC VECTOR

	PETRO-PETERS/SEC	LUNAR R-R/HR	PT - PT/SEC	EQ - EQ/HR	
X =	.9051E+06	X = .1421E+06	X = .5375E+03	V =	.5833152E+04
Y =	.1353E+07	Y = .2127E+06	Y = .8041E+03	S =	.1973E+04
Z =	.6237E+06	Z = .9805E+05	Z = .3706E+03	P =	.2843E+03
XD=	.1344E+02	XD= .2113E+01	XD= .7986E-02	A =	.5900E+04
YD=	.5234E+07	YD= .8227E+06	YD= .3110E+04	LO=	.5E+06
ZD=	.9321E+03	ZD= .1465E+03	ZD= .5537E+00	LA=	.1E+07

MP= .97061957E+01 MA= .1941E+03 PER .12036900E+03 W = -.1326E+03 E = .2473E+02 H = .1698E+05

VEH 3 STA ID CSM TIME- SEC 419783.359 HOURS 116.49494
TIME- GMT HRS 113 MIN 29 SEC 48.36 GET HRS 98 MIN 55 SEC 50.99
CD .00 AREA .000 WEIGHT 37796.000

CSM LUNAR GRAPHIC VECTOR

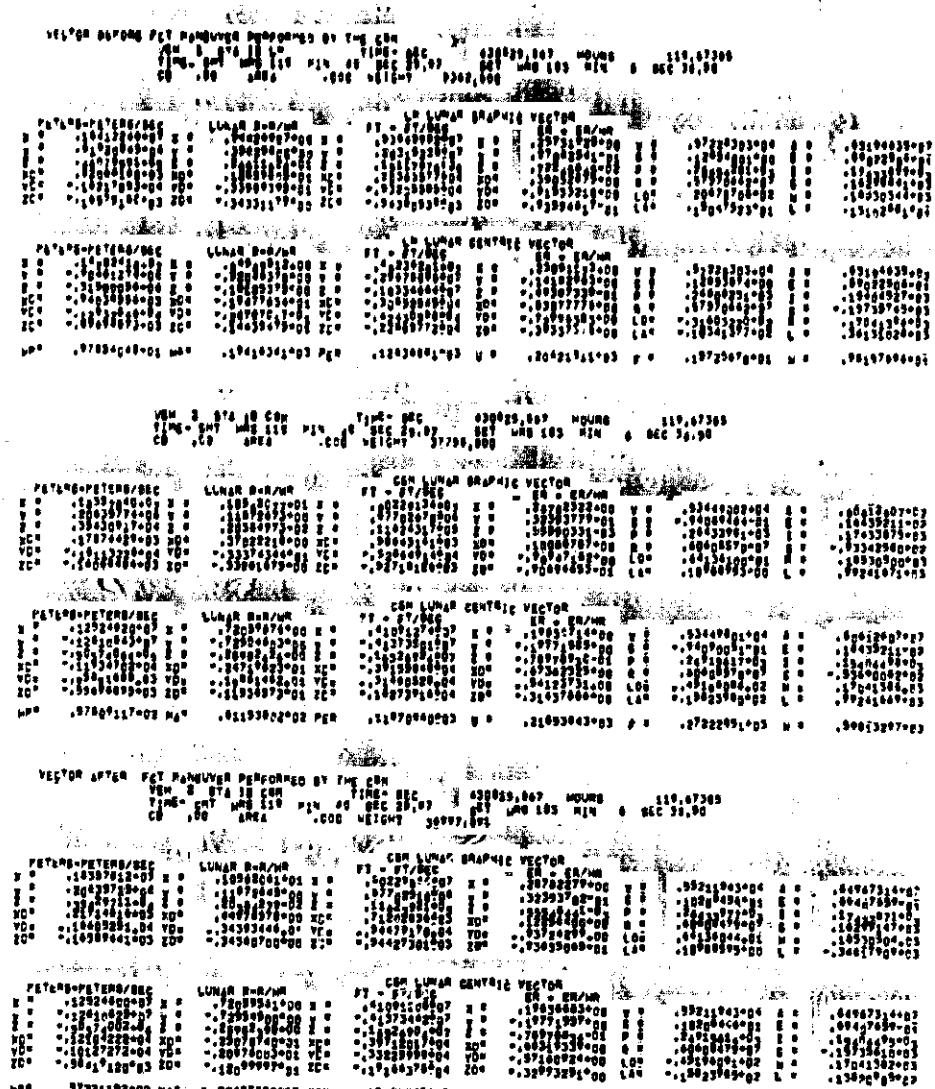
	PETRO-PETERS/SEC	LUNAR R-R/HR	PT - PT/SEC	EQ - EQ/HR	
X =	.1208E+07	X = .1901E+06	X = .3954E+03	V =	.5339E+04
Y =	.1376E+07	Y = .2163E+06	Y = .4504E+03	S =	.1986E+04
Z =	.5717E+06	Z = .8988E+05	Z = .2077E+03	P =	.2863E+03
XD=	.1352E+02	XD= .2125E+01	XD= .4424E-02	A =	.6046E+04
YD=	-.1E+07	YD= -.2E+06	YD= .3466E+04	LO=	.4E+06
ZD=	-.1E+07	ZD= -.2E+06	ZD= .1302E+04	LA=	.1E+07

					.5339E+04
					.1986E+04
					.2863E+03
					.6046E+04
					.4E+06
					.1E+07

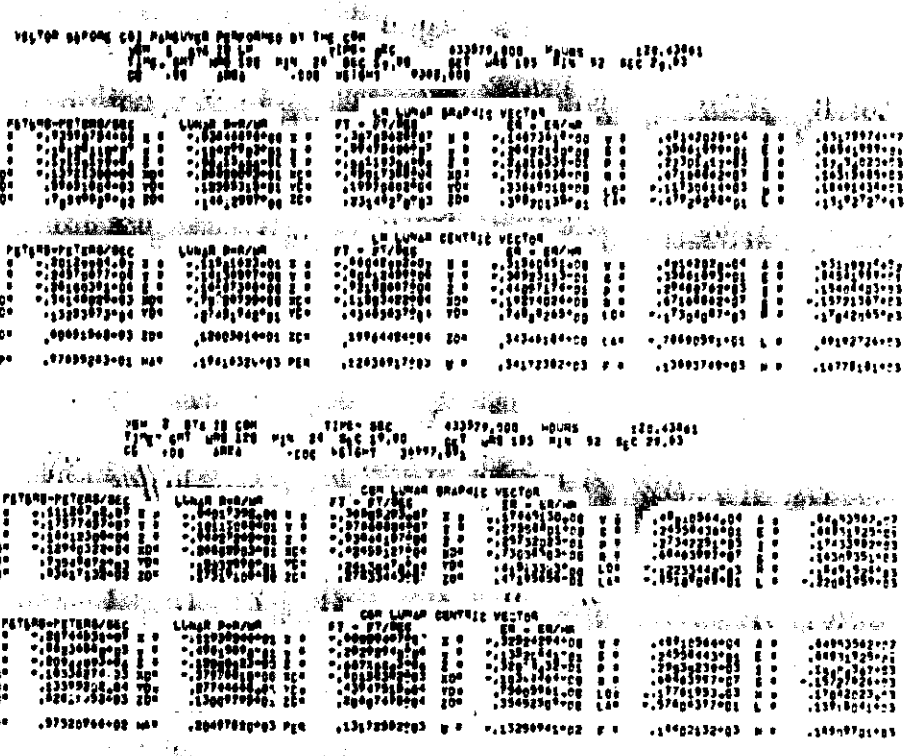
CSM LUNAR CENTRIC VECTOR

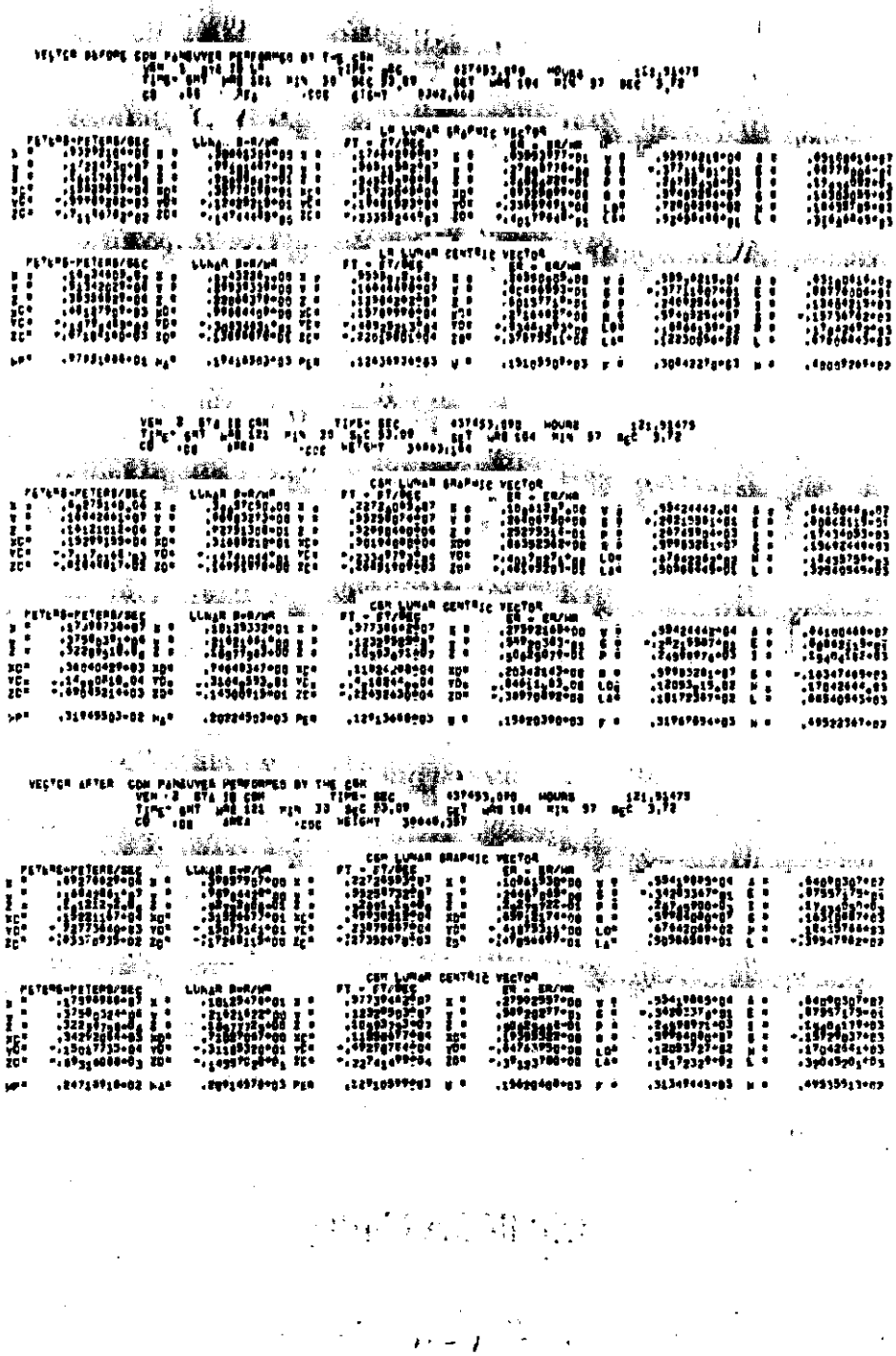
	PETRO-PETERS/SEC	LUNAR R-R/HR	PT - PT/SEC	EQ - EQ/HR	
X =	.1032E+07	X = .1624E+06	X = .4010E+03	V =	.5339E+04
Y =	.1645E+07	Y = .2588E+06	Y = .6393E+03	S =	.1986E+04
Z =	.8953E+06	Z = .1408E+06	Z = .3479E+03	P =	.2863E+03
XD=	-.1777E+02	XD= -.2796E+01	XD= -.6910E-02	A =	.6046E+04
YD=	-.1E+07	YD= -.2E+06	YD= .3466E+04	LO=	.4E+06
ZD=	-.1E+07	ZD= -.2E+06	ZD= .1302E+04	LA=	.1E+07

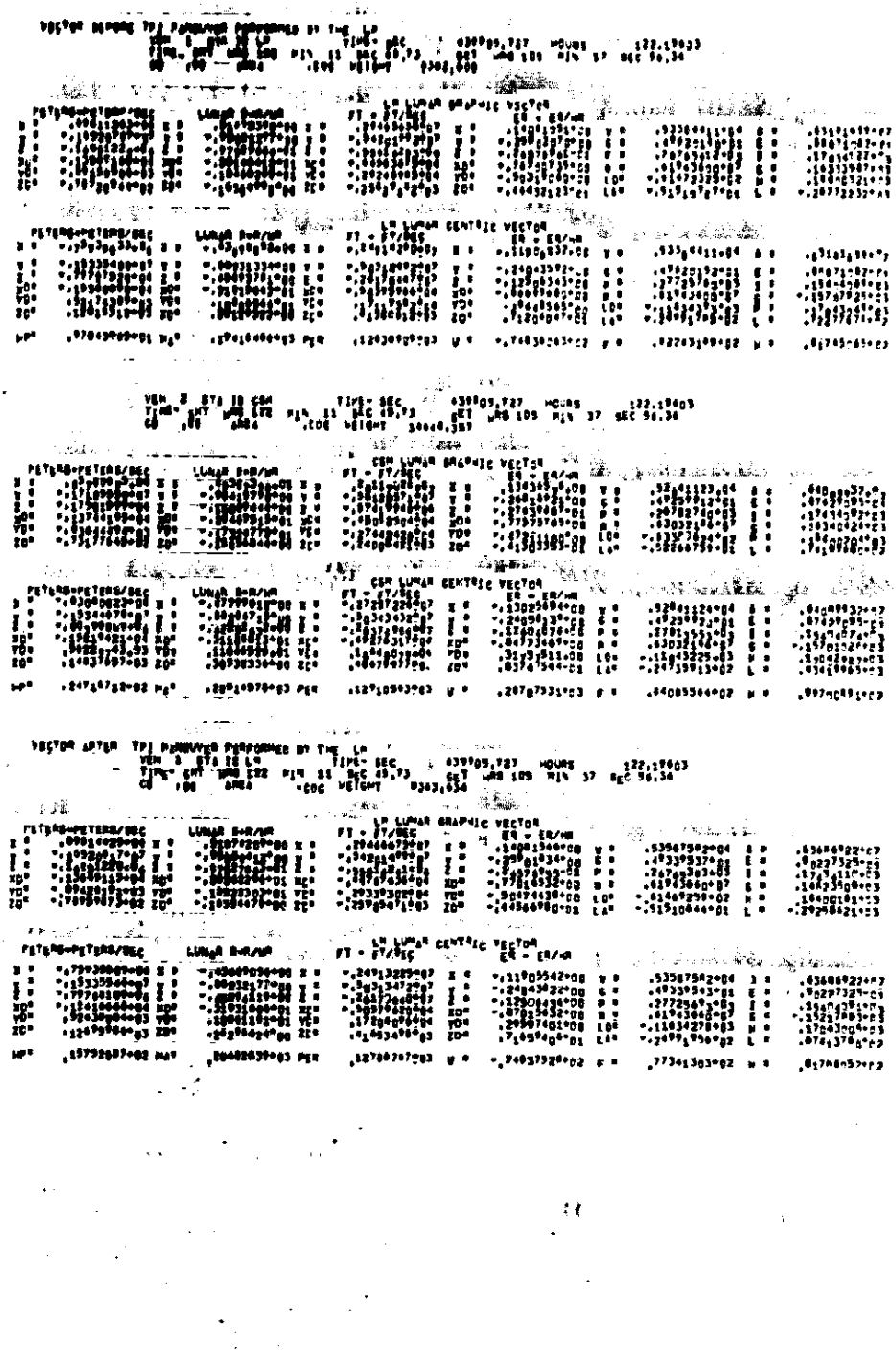
MP= .97069663E+02 MA= .6119334E+02 PER .11709E+03 W = .1779E+03 E = .2246E+02 H = .6074E+04

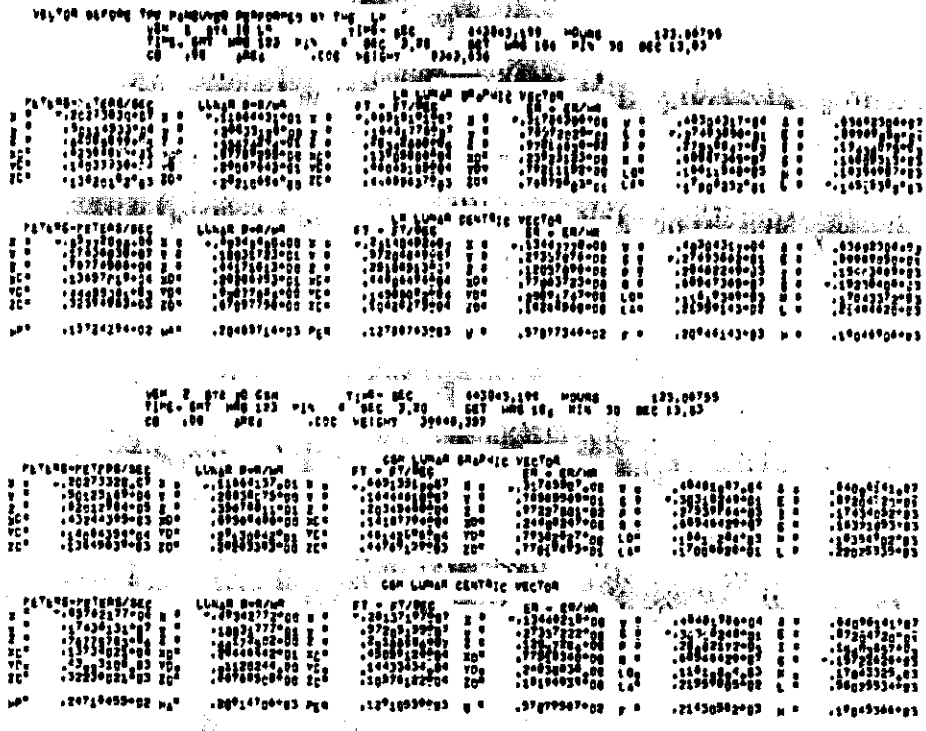


UNCLASSIFIED

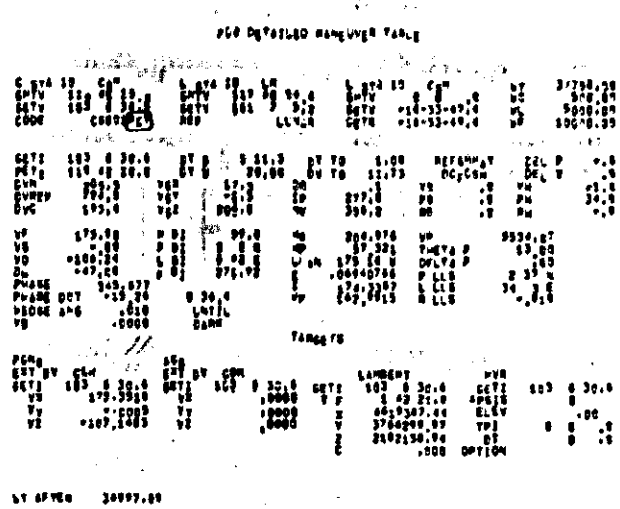








8.2 DETAILED MANEUVER TABLES



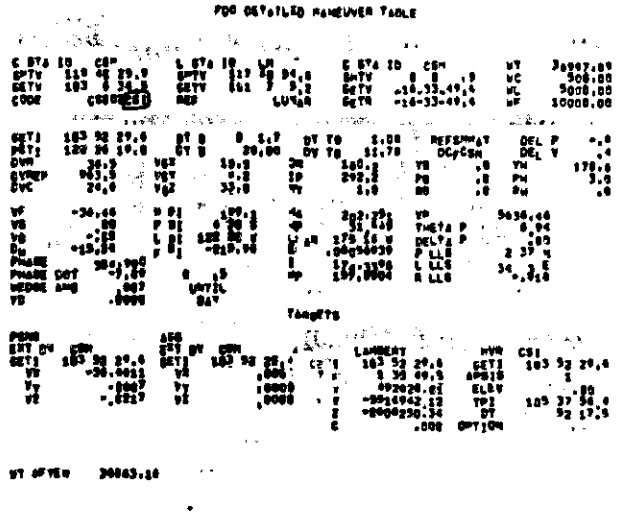
PDO DETAILED MANEUVER TABLE

C STA ID	CSM		L STA ID	VH		L STA ID	CSM		WT	3?398.39					
GMTV	118 46 29.0		GMTV	117	46 30.4	GMTV	0 0 .0		WC	500.00					
GETV	103 0 30.4		GETV	101	0 0.2	GETV	+16:33:49.4		WL	5000.00					
CODE	COMPUTED		REF		LUNAR	GETR	+16:33:49.4		WF	10008.00					
GET1	103 46 29.4		DT 0	0 1.0		DT TO	1.00	REFSMMAT		DEL P	+.0				
PET1	118 46 00.0		DT 0	30.00		DV TO	11.73	DC/CSM		DEL Y	.0				
DVM	36.3		VGT	10.3		ZH	160.3	YB	.0	YM	178.6				
DVREM	953.3		VGT	0.2		TO	292.3	PB	.0	PM	3.0				
DVC	24.9		VG	32.0		VF	1.0	RB	.0	RM	.0				
VF	179.98		P DI	99.0		HA	200.076	VH	9536.67						
VS	.00		P DI	0.0		HP	97.321	THETA P	13.00						
YD	+180.24		L DI	0.0		LA/AN	175 [0 N	DELTA P	.03						
DH	+47.60		P DI	975.92			.0004<0766	P LLS	2 37 N						
PHASE	349.977						174:33?7	L LLS	34 .3.E						
PHASE DOT	+19.24		0 30.0			HP	[07.?015	R LLS	.0.0						
NODE ANG	.010		UNTIL												
YD	.0000		BANK												

TARGETS

PGMD			ADD												
EXT DV	CSM		EXT DV	CSM				LAMBERT		HVR					
GET1	103 0 30.4		GET1	103	0 32.4	GET1	103 0 30.4		GET1	103 0 30.4					
VS	179.9910		VS		.0000	T P	1 43 21.0		APSIS	0					
VT	.0000		VT		.0000	X	66?5307.44		ELEV	.00					
VZ	+107.1483		VZ		.0000	Y	37464?0?.??		TPI	0 0 .?					
						Z	21402150.?4		DT	0 .?					
						C	.000	OPTION							

DT OF VEH 30997.89



PDO DETAILED MANEUVER TABLE

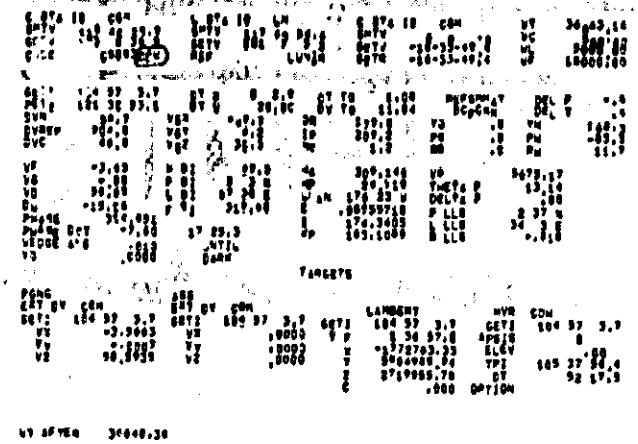
C STA ID	CSM		L STA ID	VH		L STA ID	CSM		WT	3?007.89					
GMTV	118 46 29.0		GMTV	117	46 30.4	GMTV	0 0 .0		WC	500.00					
GETV	103 0 30.4		GETV	101	0 0.2	GETV	+16:33:49.4		WL	5000.00					
CODE	COMPUTED		REF		LUNAR	GETR	+16:33:49.4		WF	10008.00					
GET1	103 52 29.4		DT 0	0 1.0		DT TO	1.00	REFSMMAT		DEL P	+.0				
PET1	118 36 19.8		DT 0	30.00		DV TO	11.78	DC/CSM		DEL Y	.4				
DVM	36.3		VGT	10.3		ZH	160.3	YB	.0	YM	178.6				
DVREM	953.3		VGT	0.2		TO	292.3	PB	.0	PM	3.0				
DVC	24.9		VG	32.0		VF	1.0	RB	.0	RM	.0				
VF	-36.46		P DI	99.1		HA	202.?5?	VH	9636.46						
VS	.00		P DI	0.0		HP	97.?49	THETA P	8.94						
YD	-.?0		L DI	0.0		LA/AN	175 [0 N	DELTA P	.05						
DH	+15.?5		P DI	+819.94			.0005<0?30	P LLS	2 37 N						
PHASE	304.?00						174:33?0	L LLS	34 .3.E						
PHASE DOT	-?.??		0 .5			HP	107.0004	R LLS	.0.0						
NODE ANG	.007		UNTIL												
YD	.0000		BANK												

TARGETS

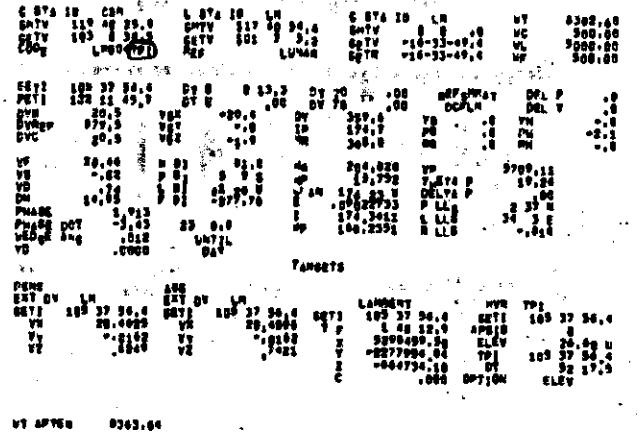
PGMD			ADD												
EXT DV	CSM		EXT DV	CSM				LAMBERT		HVR	CSI				
GET1	103 52 29.4		GET1	103 52 29.4		CSI	103 52 29.4		GET1	103 52 29.4					
VS	-36.4451		VS		.0001	T P	0 30 00.5		APSIS	1					
VT	.0007		VT		.0000	X	672020.?5		ELEV	.00					
VZ	-.?5??		VZ		.0000	Y	-?5?4942.?2		TPI	105 37 54.4					
						Z	+0000250.34		DT	52 17.5					
						C	.000	OPTION							

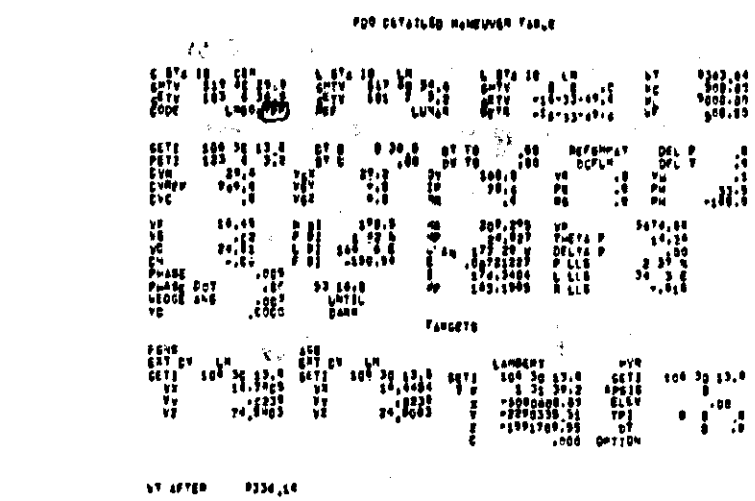
DT OF VEH 30863.10

FOR DESIRED MANEUVER TABLE

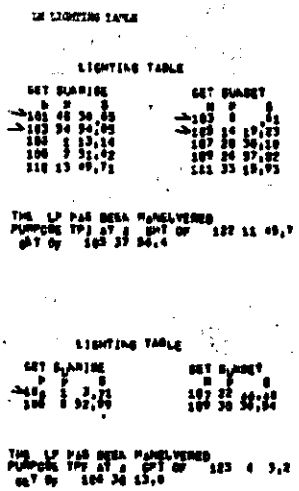


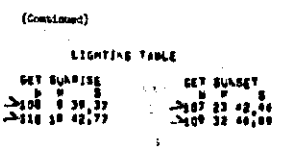
FOR DESIRED MANEUVER TABLE

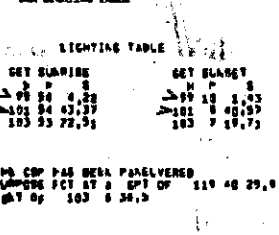




8.3 SUNRISE-SUNSET TABLES







(Continued)

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
h	m	s	h	m	s
153	52	27.05	183	7	28.76
156	4	4.07	186	19	5.14

THE CSM HAS BEEN MANEUVERED
PURPOSE CSI AT A GMT OF 120 76 10.0
GET OF 153 52 29.0

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
h	m	s	h	m	s
156	1	36.96	185	19	31.32
158	14	35.68	187	24	30.04

THE CSM HAS BEEN MANEUVERED
PURPOSE SOI AT A GMT OF 121 30 53.1
GET OF 154 57 3.7

(Continued)

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
h	m	s	h	m	s
156	1	36.96	185	19	31.32
158	14	35.68	187	24	30.04

8.4 MSFN DEEP-SPACE TRACKING

TRACKING FOR THE LM WITH THE GET FROM THE LIFTOFF TIME OF THE CSM TRACKING TABLE

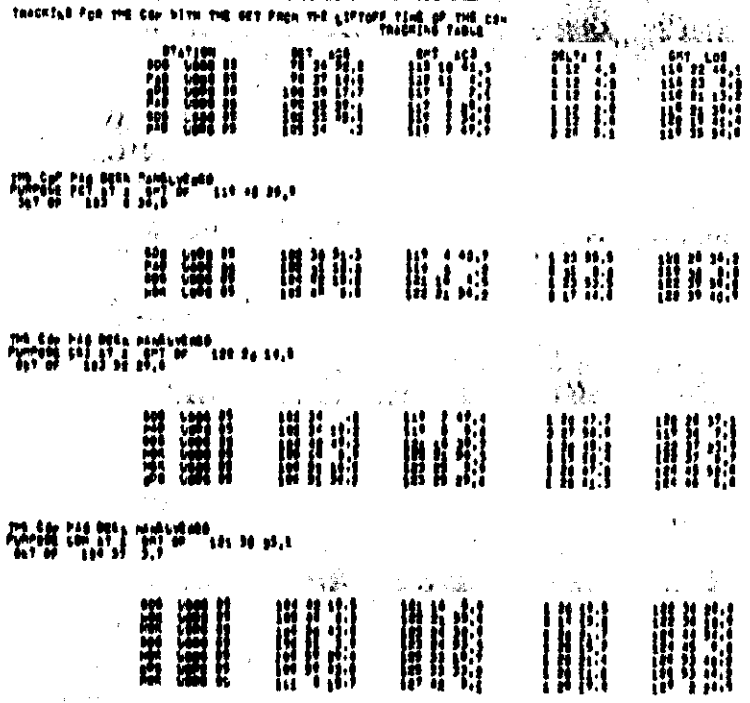
	STATION		GET	ACQ		GMT	ACQ		DELTA T		GMT	LOS	
	GDS	USBS	85	102	32	55.5	117	8	44.1	1	17	48.6	119	24	7.6
	PAD	USBS	85	102	33	23.4	117	9	12.0	1	17	48.6	119	24	24.5
	GDS	USBS	85	102	38	57.6	117	14	47.2	1	17	49.6	120	30	5.5
	PAD	USBS	85	102	39	16.4	117	14	40.0	1	17	49.6	120	30	5.5
	GDS	USBS	85	104	45	12	119	19	53.8	1	22	54.9	124	36	7.1
	HSK	USBS	85	104	45	12	119	19	53.8	1	17	57.2	122	36	5.8
	HSK	USBS	85	106	40	6.0	121	14	47.2	1	17	57.2	122	36	5.8
	HSK	USBS	85	106	40	48.0	121	14	49.2	1	17	57.2	122	36	49.4
	GDS	USBS	85	106	41	.8	121	14	30.2	1	17	57.2	122	36	49.4
	HSK	USBS	85	108	35	42.8	123	8	32.8	1	17	57.2	124	31	29.6
	GDS	USBS	85	108	36	37.3	123	9	27.3	1	17	57.2	124	31	29.6
	HSK	USBS	85	110	30	39.6	125	3	34.6	1	17	57.2	126	26	26.8

THE LP HAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 122 11 45.7
GET OF 155 37 34.4

GDS	USBS	85	104	43	36.9	121	17	26.5	1	18	49.5	122	36	19.8
HSK	USBS	85	108	44	9.3	125	22	59.9	1	18	49.5	122	36	58.6
HSK	USBS	85	108	44	49.3	125	22	59.9	1	18	49.5	122	36	58.6
GDS	USBS	85	108	45	8.1	125	24	57.5	1	18	49.5	124	43	26.9
												124	43	26.9

THE LP HAS BEEN MANEUVERED
PURPOSE TPF AT A GMT OF 123 4 3.2
GET OF 156 30 33.0

HSK	USBS	85	106	50	43.6	123	24	33.1	1	20	23.5	124	44	56.6
GDS	USBS	85	106	51	4.0	123	24	53.5	1	20	23.5	124	45	16.6
HSK	USBS	85	108	55	38.0	125	32	28.2	1	20	23.5	126	52	47.4
GDS	USBS	85	108	55	58.3	125	32	38.2	1	20	23.5	126	52	47.4
HSK	USBS	85	111	0	10.5	127	42	7.9	1	20	21.0	129	2	24.0



9.0 RESCUE AFTER A PARTIAL INSERTION MANEUVER OF 80 FPS

TABLE IX.- SUMMARY OF SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A PARTIAL INSERTION MANEUVER OF 80 FPS[a]

Active vehicle	Maneuver	Engine	Approximate revolutions from the previous maneuver
LM	Partial LM insertion (FCT)[b]	APS	5/6
CSM	Rescue initiation (H)[b]	SPS	1/2
CSM	CSI (C1)[b]	SPS	1/2
CSM	CDH (SR)[b]	SPS	1
LM	TPI	LM RCS	1/4
LM	TPF	LM RCS	1/3

[a]LM rendezvous with a coelliptic Δh of 15 n. mi. below the CSM and TPI one revolution later than nominal time.

[b]The printout maneuver terminology is given in parentheses.

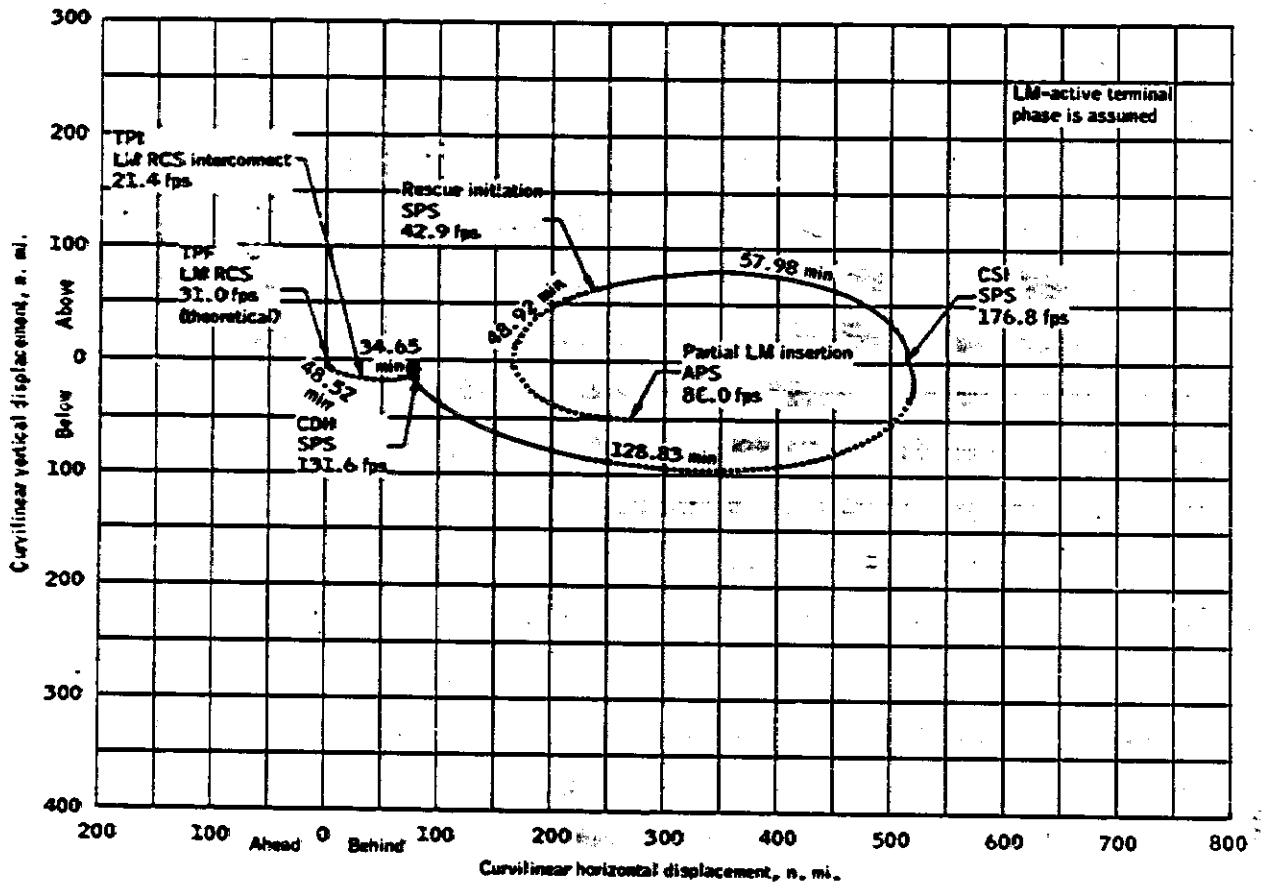
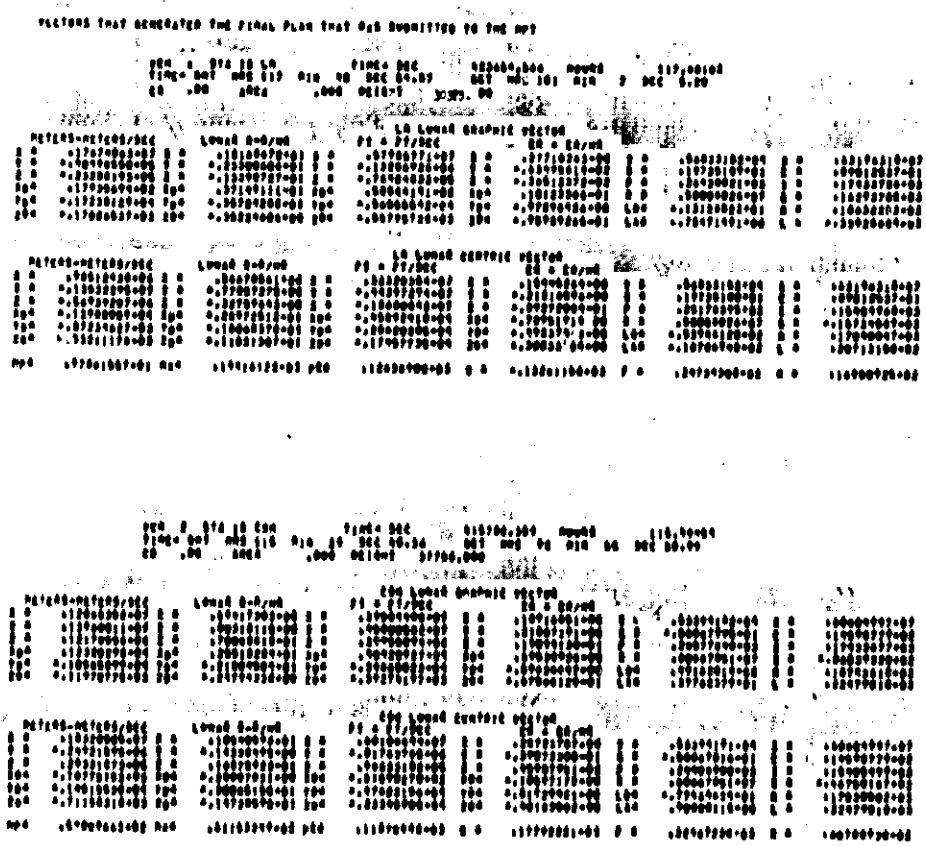
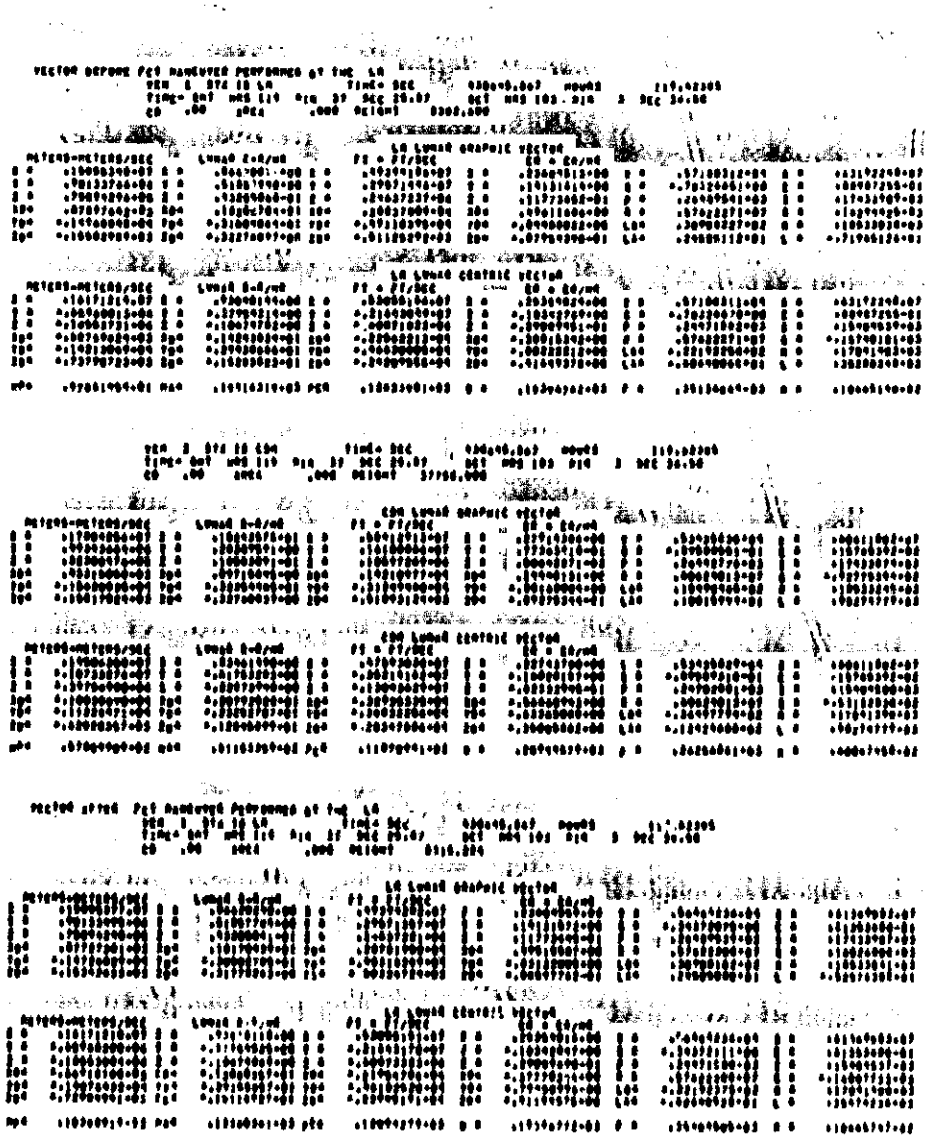


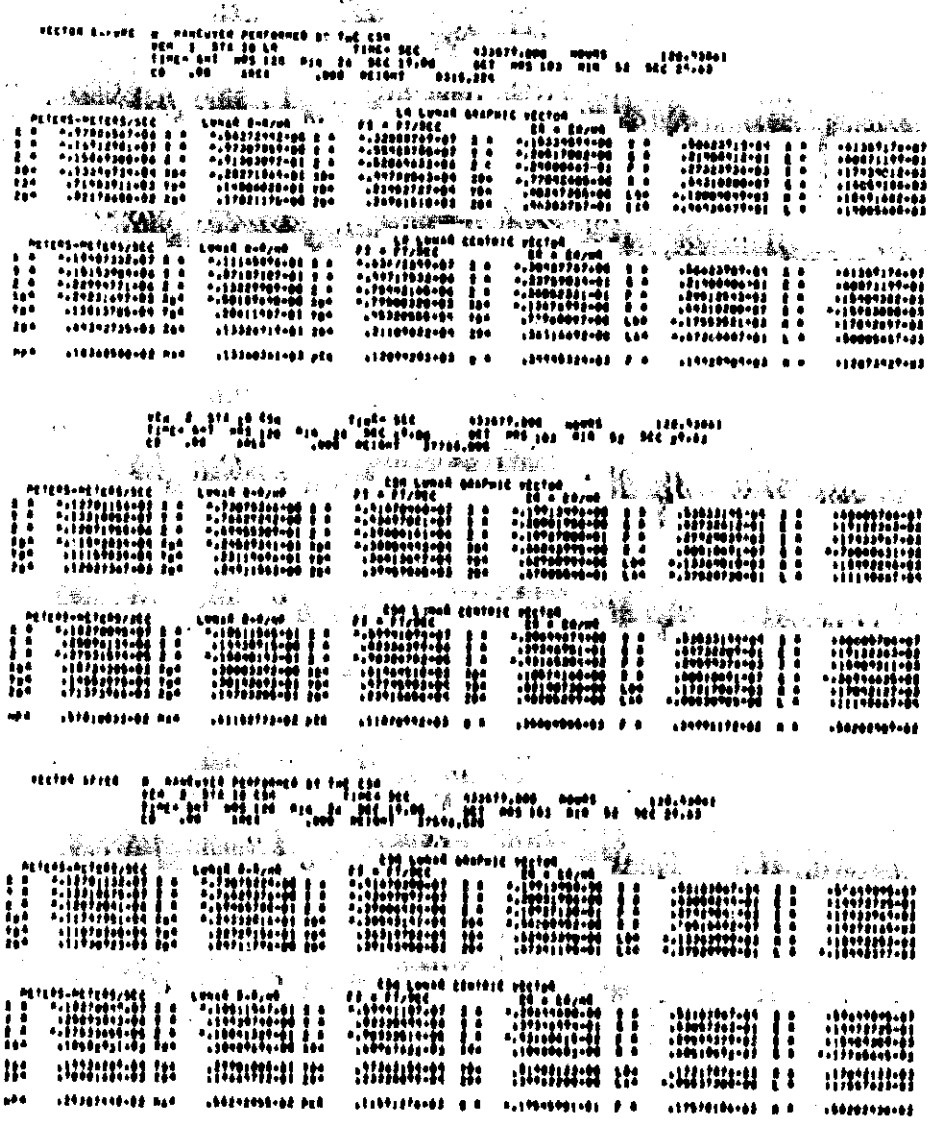
Figure 9.- Relative motion (curvilinear, CSM-centered) for rescue after partial LM insertion of 80 fps.

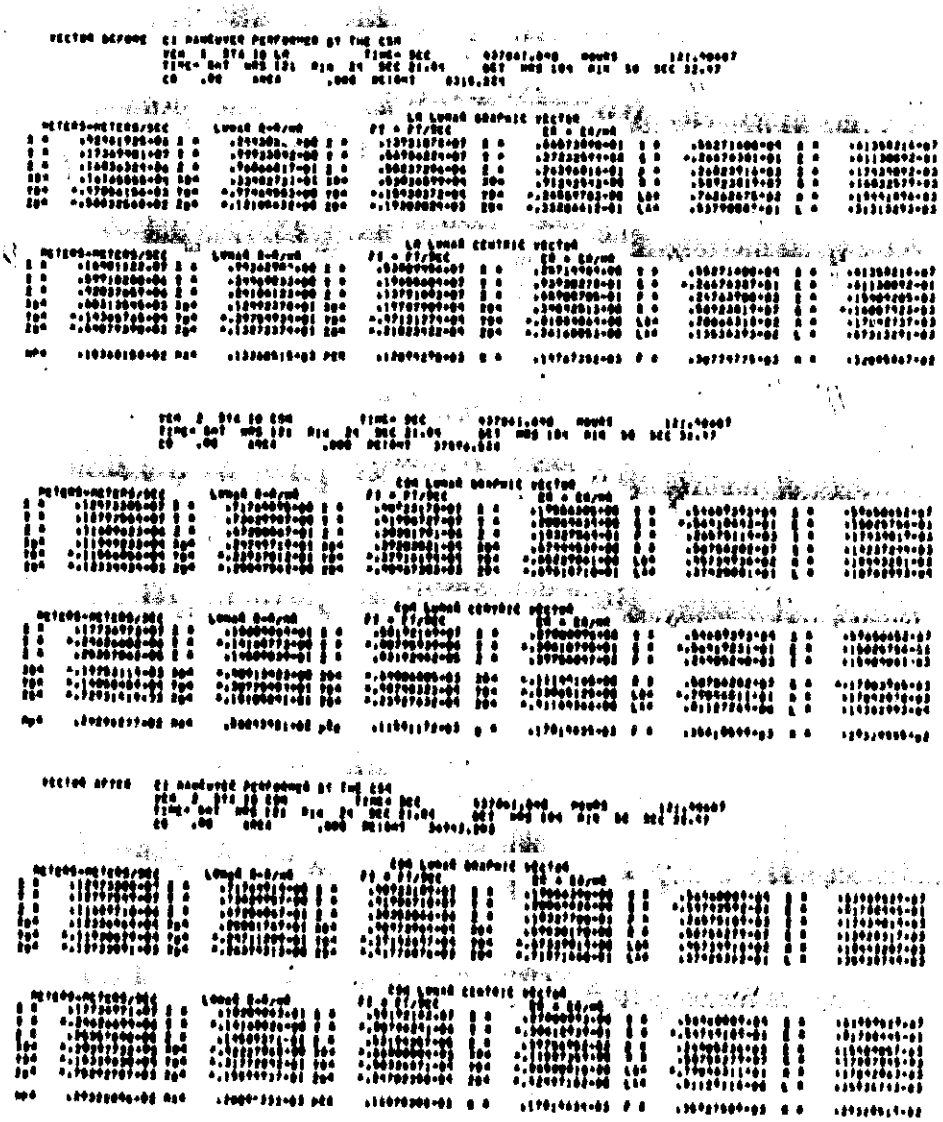
9.0 RESCUE AFTER A PARTIAL INSERTION MANEUVER OF 80 FPS

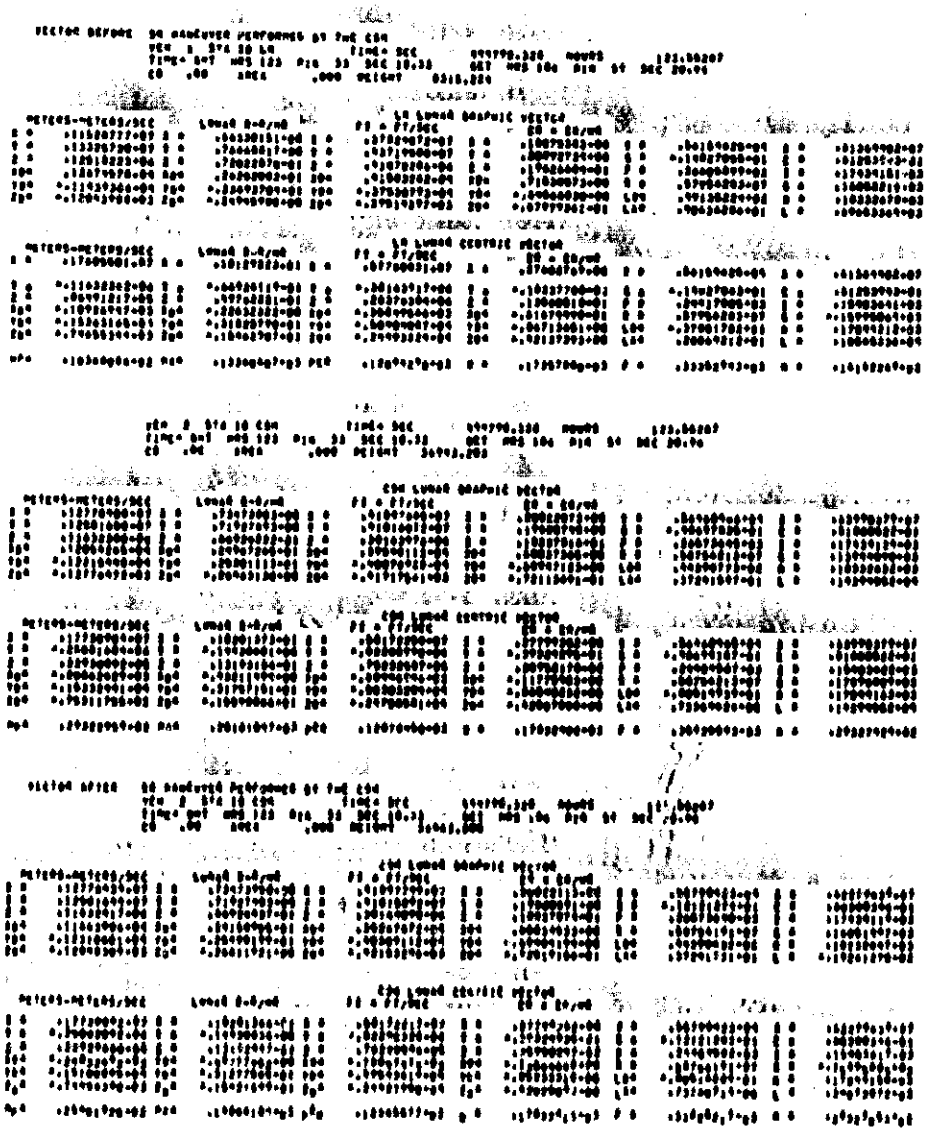
9.1 VECTORS

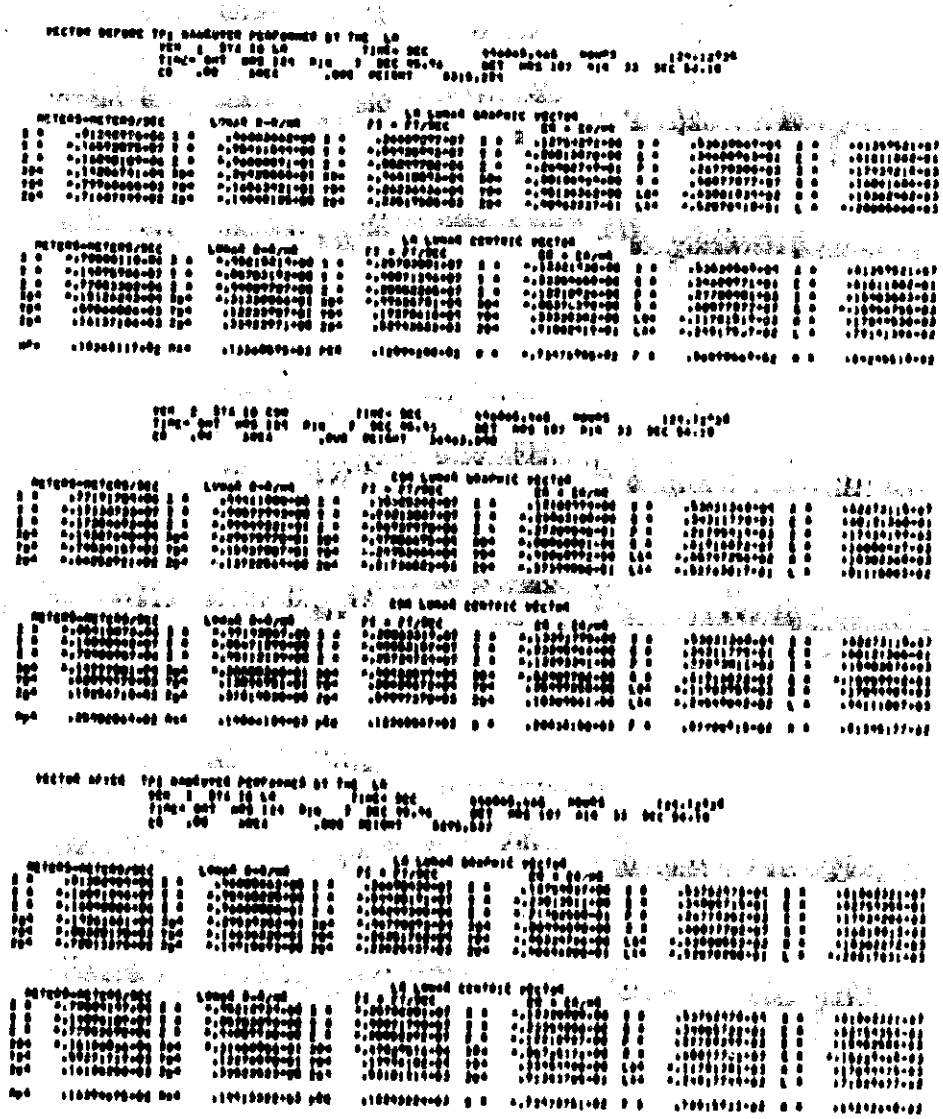


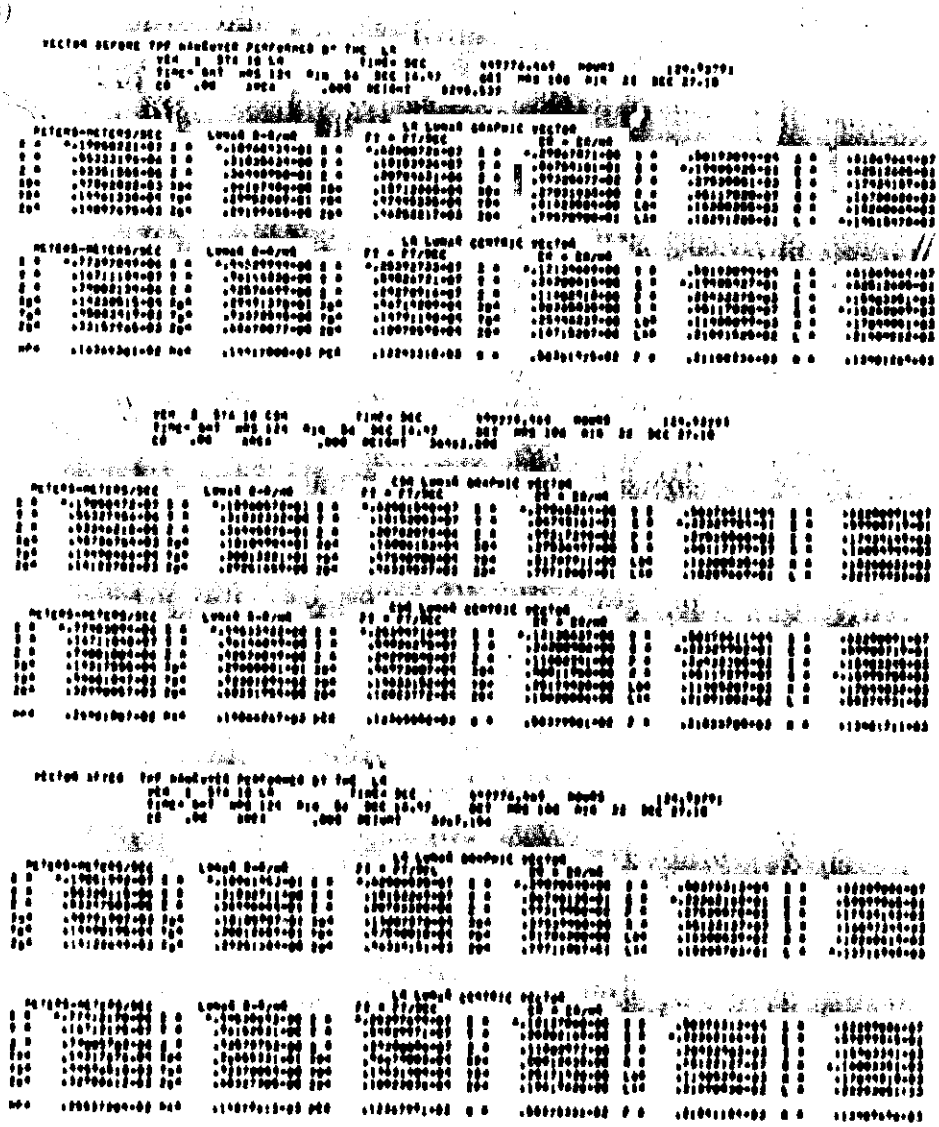




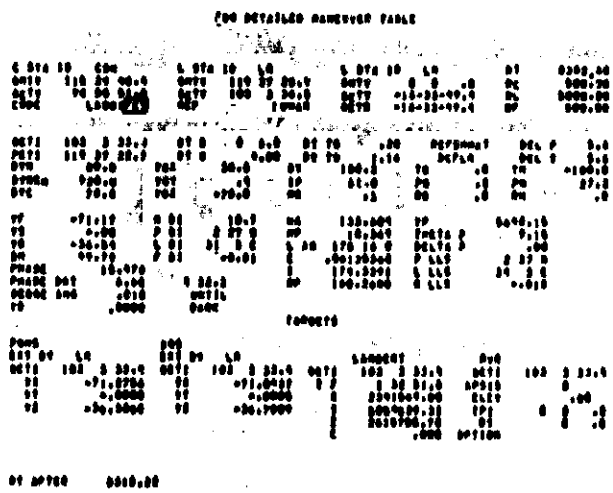


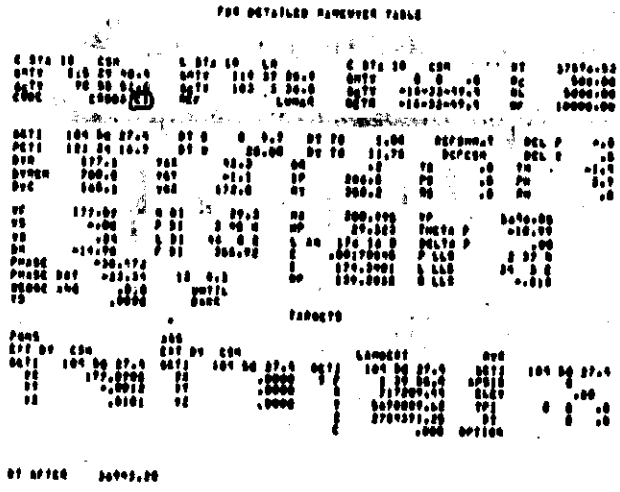


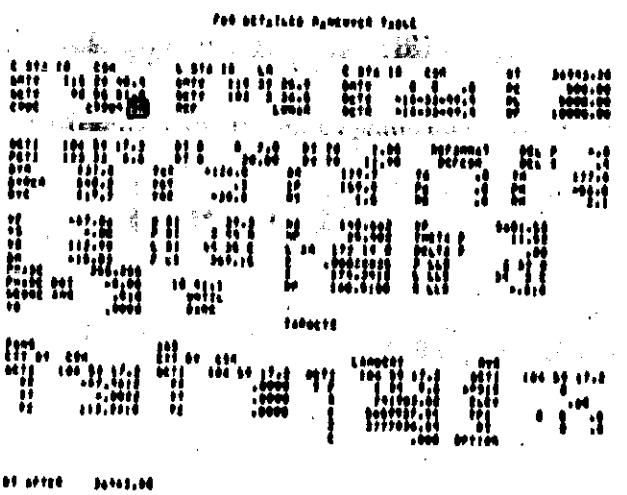


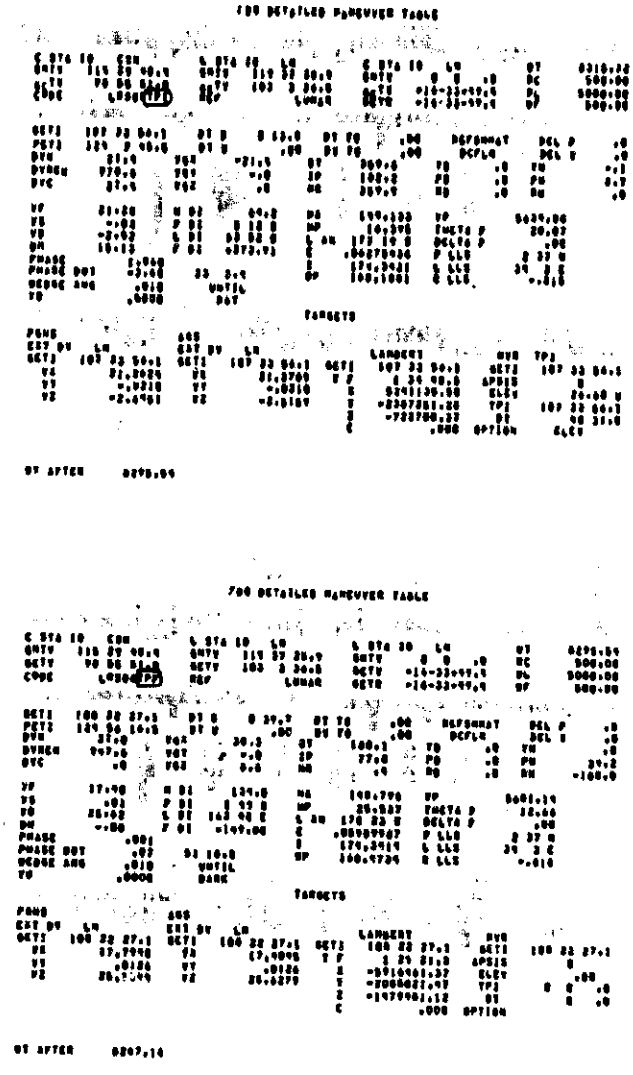


9.2 DETAILED MANEUVER TABLES








700 DETAILED MANEUVER TABLE
TARGETS
700 DETAILED MANEUVER TABLE
TARGETS

9.3 SUNRISE-SUNSET TABLES

LM LIGHTING TABLE

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
101	98	30.00	103	0	.01
103	94	54.06	106	14	19.23

THE LM HAS BEEN MANEUVERED
PURPOSE FCT AT A GMT OF 119 37 29.9
GET OF 103 3 36.5

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
103	96	22.50	103	0	10.04
105	86	15.06	105	1	2.70
107	57	9.03	107	9	56.97
109	88	1.30	109	10	50.23
111	80	54.06	113	11	43.49

THE LM HAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 125 2 49.8
GET OF 107 33 54.1

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
107	54	50.50	109	12	55.56
109	59	10.69	111	16	17.75

THE LM HAS BEEN MANEUVERED
PURPOSE TPF AT A GMT OF 129 56 14.0
GET OF 108 22 57.1

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
110	0	0.00	109	13	52.91
112	3	42.98	111	17	30.46

CSM LIGHTING TABLE

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
99	96	4.28	99	10	0.43
101	95	43.37	101	0	48.07
103	93	22.83	103	7	19.71
106	91	1.66	105	9	50.66

THE CSM HAS BEEN MANEUVERED
PURPOSE H AT A GMT OF 120 36 19.0
GET OF 103 53 39.6

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
103	83	22.01	105	2	10.86
105	69	14.26	106	88	2.03

THE CSM HAS BEEN MANEUVERED
PURPOSE CI AT A GMT OF 131 24 21.0
GET OF 109 88 32.5

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
105	97	98.87	105	2	58.54
107	88	23.67	107	13	34.09

THE CSM HAS BEEN MANEUVERED
PURPOSE SR AT A GMT OF 123 33 19.3
GET OF 106 59 21.8

LIGHTING TABLE

GET SUNRISE			GET SUNSET		
D	H	M	D	H	M
107	84	28.74	107	18	18.01
110	0	0.07	109	13	51.96
112	3	38.13	111	17	27.98
112	3	38.13	113	21	3.98

9.4 MSFN DEEP-SPACE TRACKING

TRACKING FOR THE LM WITH THE GET FROM THE LIFTOFF TIME OF THE CSM
TRACKING TABLE

STATION	GET ACQ	GMT ACQ	DELTA H	GMT LOS
GDS VSBS 85	100 32 56.5	117 8 49.7	1 17 19.0	118 01 7.0
MAD VSBS 85	100 33 03.5	117 8 56.8	1 17 12.9	118 01 20.2
GDS VSBS 85	100 36 57.0	117 12 50.2	1 17 16.9	118 05 0.9
MAD VSBS 85	100 39 04.9	117 14 8.4	0 22 04.9	117 06 .7
GDS VSBS 85	100 40 .8	117 15 57.8	1 17 17.2	118 08 .8
HSK VSBS 85	100 40 8.8	117 15 58.8	0 23 04.3	117 06 49.9

THE LM HAS BEEN MANEUVERED
PURPOSE FCT AT A GMT OF 117 17 28.9
GET OF 103 3 34.8

GDS VSBS 85	102 40 00.8	119 18 28.2	1 12 23.0	120 06 07.0
MAD VSBS 85	102 40 08.2	119 18 37.6	0 21 04.1	119 06 06.0
GDS VSBS 85	102 43 20.0	119 18 9.8	1 12 22.3	120 07 32.1
HSK VSBS 85	102 43 .1.0	119 21 51.2	0 5 20.0	120 07 14.2
HSK VSBS 85	102 43 39.7	119 19 29.1	1 12 24.2	120 07 53.4
GDS VSBS 85	102 43 56.0	119 19 47.4	1 12 20.2	120 08 7.6
HSK VSBS 85	102 44 10.3	119 19 7.6	1 12 24.6	120 08 32.2
GDS VSBS 85	102 44 33.1	119 19 21.5	1 12 17.0	120 08 38.5
HSK VSBS 85	110 42 57.9	127 16 46.9	1 12 23.7	120 09 10.6

THE LM HAS BEEN MANEUVERED
PURPOSE TPI AT A GMT OF 124 2 48.6
GET OF 107 33 54.1

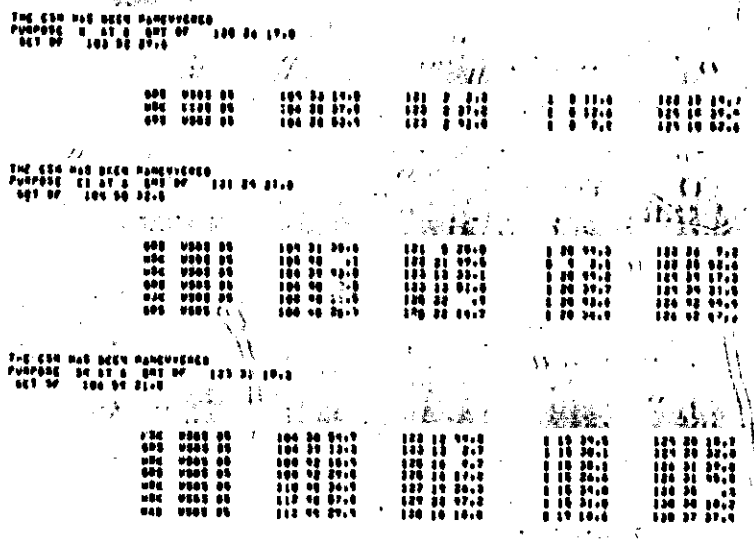
HSK VSBS 85	106 42 11.9	123 17 1.3	1 15 3.6	124 20 2.9
GDS VSBS 85	106 42 30.4	123 17 20.0	1 15 57.1	124 20 17.1
HSK VSBS 85	106 42 10.9	123 16 0.2	1 15 3.3	124 20 10.5
GDS VSBS 85	106 42 33.5	123 16 23.0	1 15 53.9	124 20 16.8

THE LM HAS BEEN MANEUVERED
PURPOSE TPF AT A GMT OF 124 56 14.6
GET OF 108 23 27.1

HSK VSBS 85	110 42 10.3	128 16 9.8	1 15 36.8	126 21 51.9
GDS VSBS 85	110 42 29.7	128 16 29.1	1 15 30.3	126 21 57.9
HSK VSBS 85	110 42 30.0	127 19 20.2	1 15 35.2	126 21 3.9
HSK VSBS 85	113 42 .4	129 22 00.0	0 15 22.7	126 20 22.2
MAD VSBS 85	113 42 20.3	130 20 10.7	0 19 23.2	126 21 47.9

TRACKING FOR THE CSM WITH THE GET FROM THE LIFTOFF TIME OF THE CSM
TRACKING TABLE

STATION	GET ACQ	GMT ACQ	DELTA H	GMT LOS
GDS VSBS 85	90 36 58.8	110 10 51.0	0 12 9.0	110 22 56.1
MAD VSBS 85	90 37 10.0	110 11 3.0	0 12 9.0	110 23 8.0
GDS VSBS 85	100 36 17.7	117 9 2.1	1 12 0.1	110 21 13.2
MAD VSBS 85	100 36 29.1	117 9 20.1	1 12 2.0	110 21 30.9
GDS VSBS 85	100 33 58.0	117 9 3.0	1 12 0.0	120 19 51.9
MAD VSBS 85	100 34 .3	117 9 19.7	0 26 9.1	117 36 59.0
GDS VSBS 85	109 32 13.7	121 6 3.1	0 10 9.0	122 10 9.0



10.0 RESCUE AFTER A ZERO CSI MANEUVER (3-MINUTE DELAY)

TABLE X.- SUMMARY FOR SEQUENCE OF EVENTS FOR A RESCUE INITIATED AFTER A ZERO CSI MANEUVER (3-MINUTE DELAY)[a]

Active vehicle	Maneuver[b]	Engine	Approximate revolutions from the previous maneuver
CSM	CSI	SPS	1/2
CSM	CDH	SPS	1/2
CSM	TPI	SPS or SM RCS	1/4
CSM	TPF	SM RCS	1/3

[a]CSM rendezvous with a coelliptic Δh of 10 n. mi. above the LM and TPI at the nominal time.

[b]Printout maneuver terminology equated to the normal terminology for this case: INS = insertion (nominal).

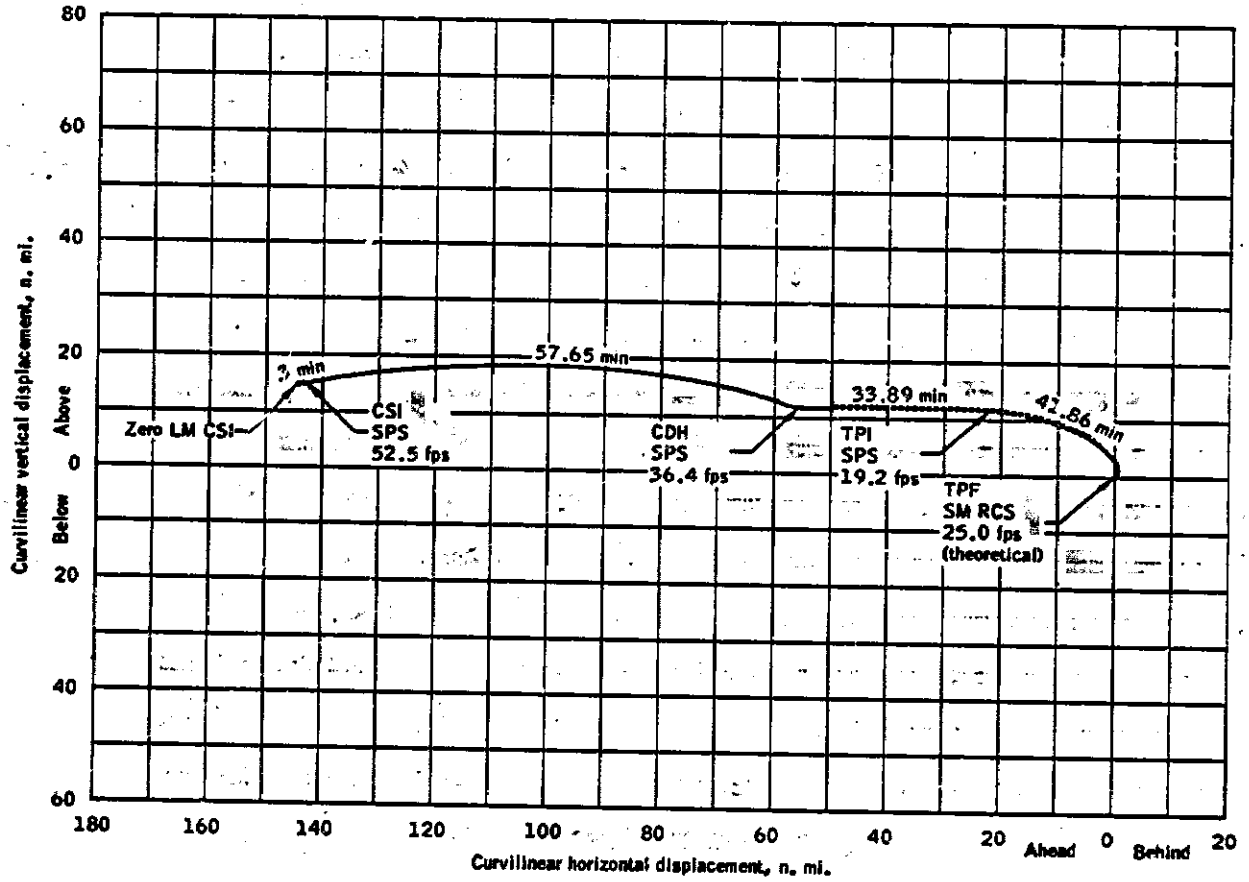
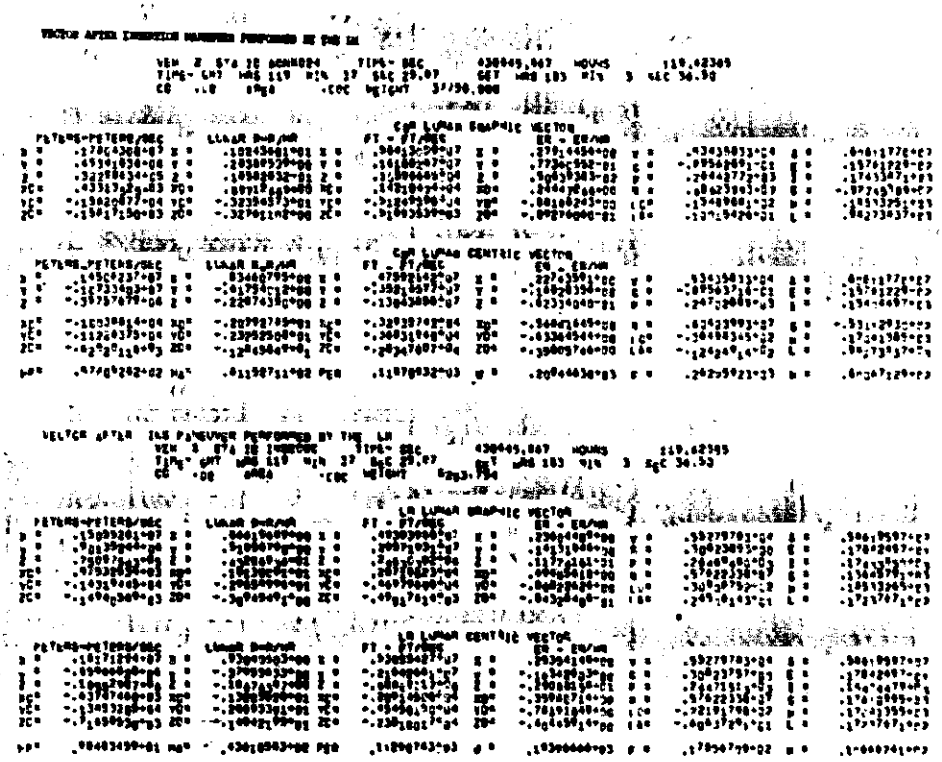
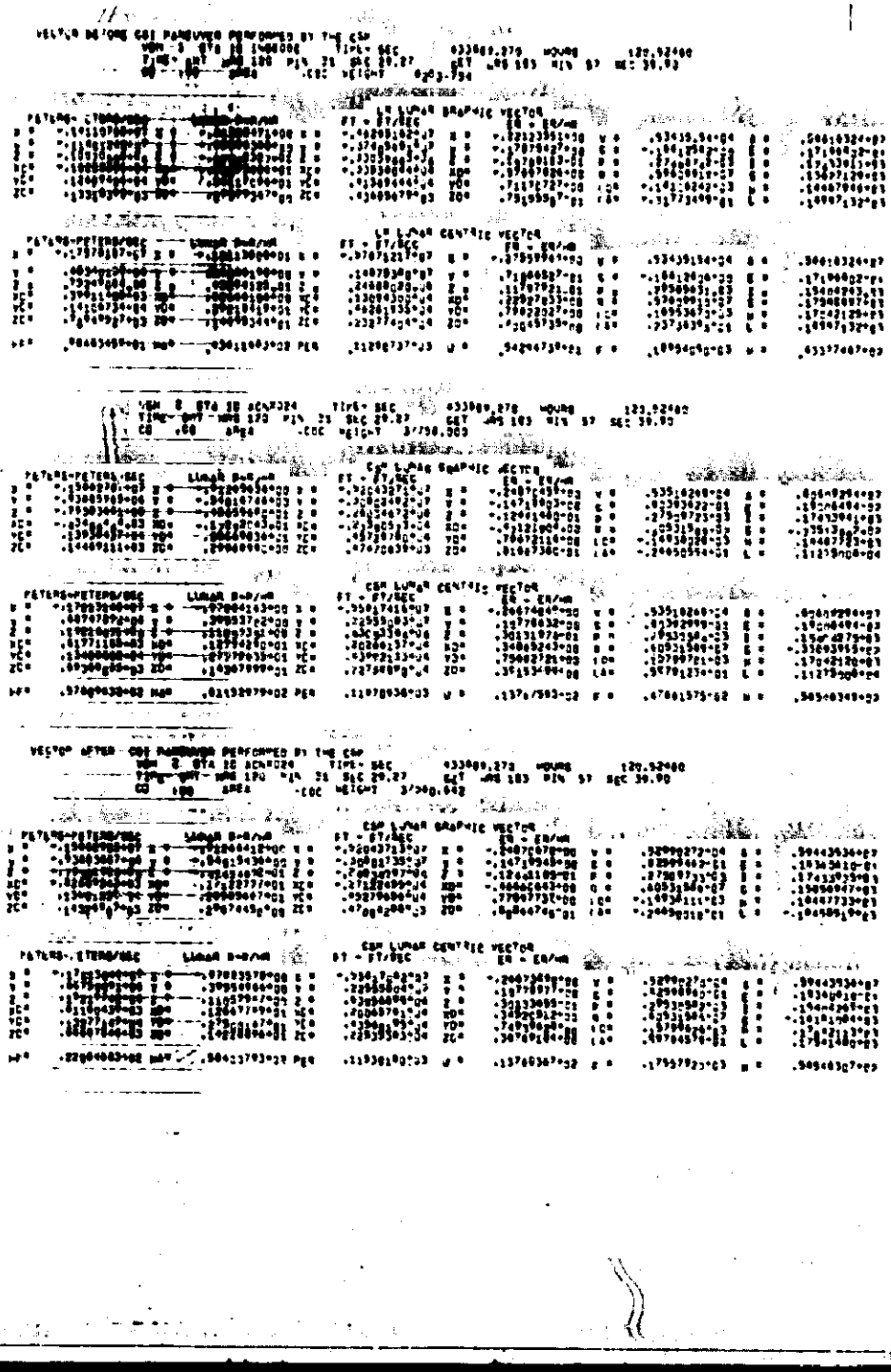


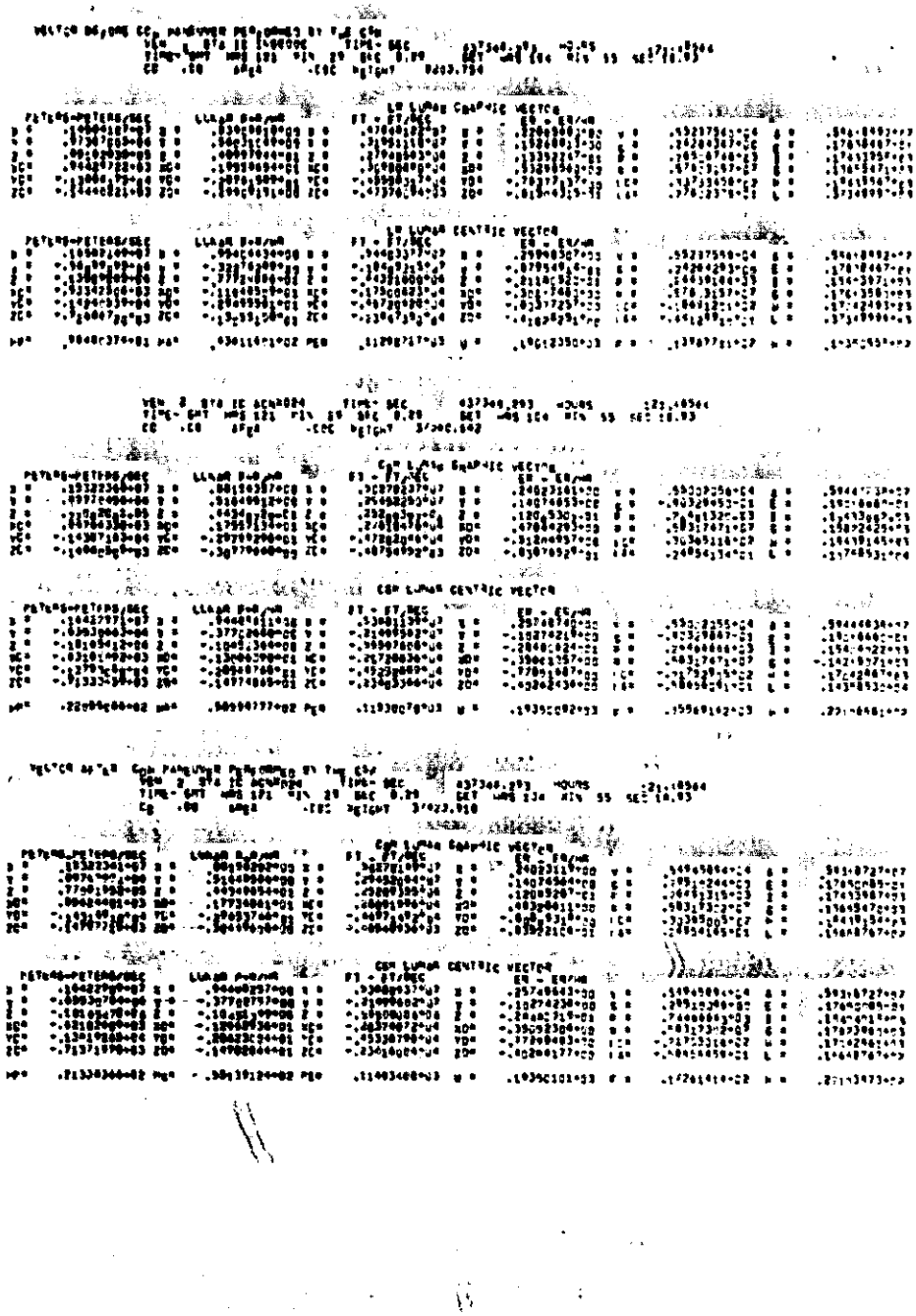
Figure 10.- Relative motion (curvilinear, LM-centered) for rescue after zero LM CSI.

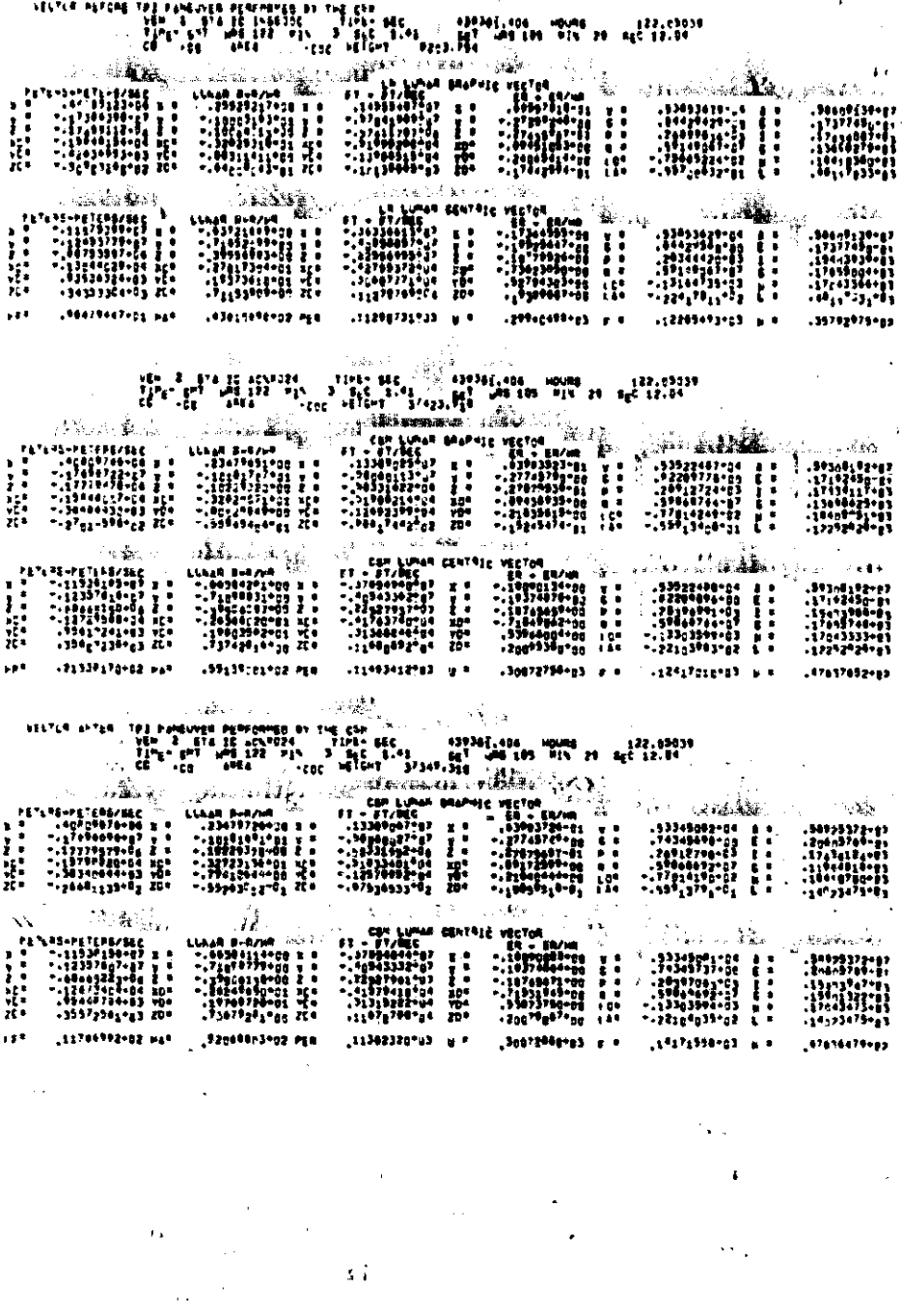
10.0 RESCUE AFTER A ZERO CSI MANEUVER (0-MINUTE DELAY)

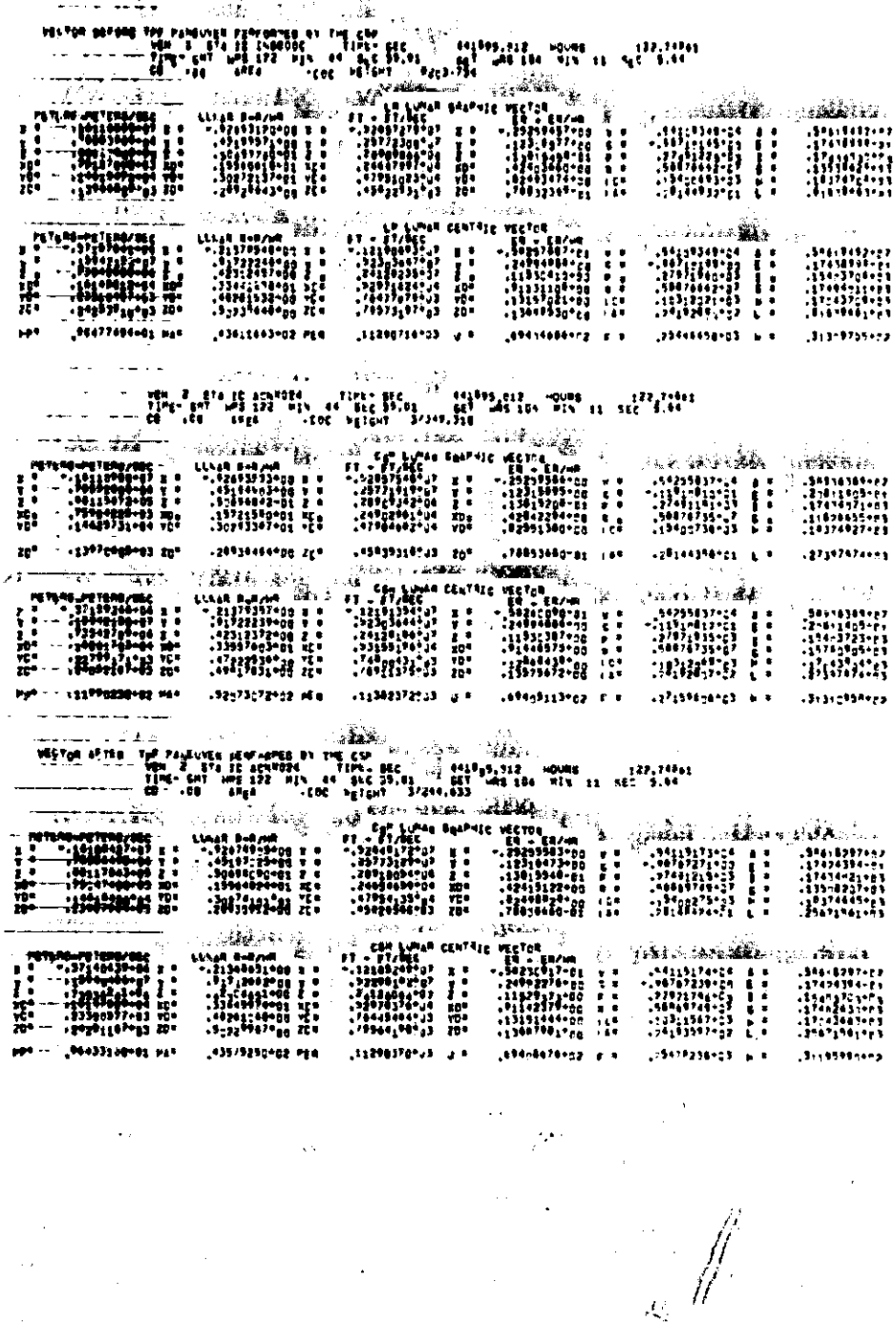
10.1 VECTORS





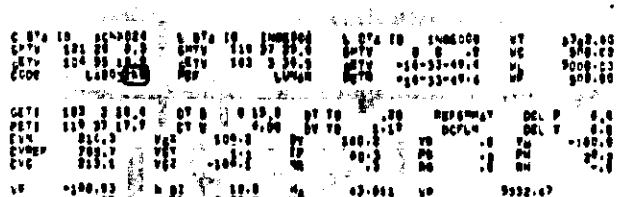




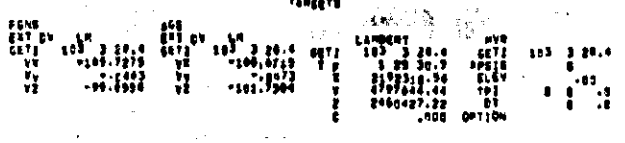


10.2 DETAILED MANEUVER TABLES

FDO DETAILED MANEUVER TABLE

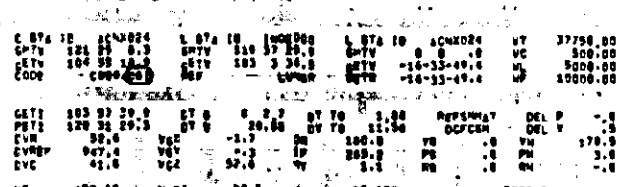


TARGETS

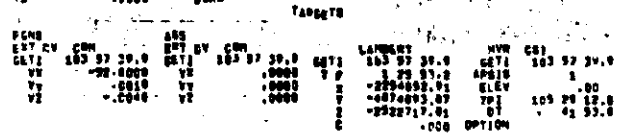


LT AFTER 0103.75

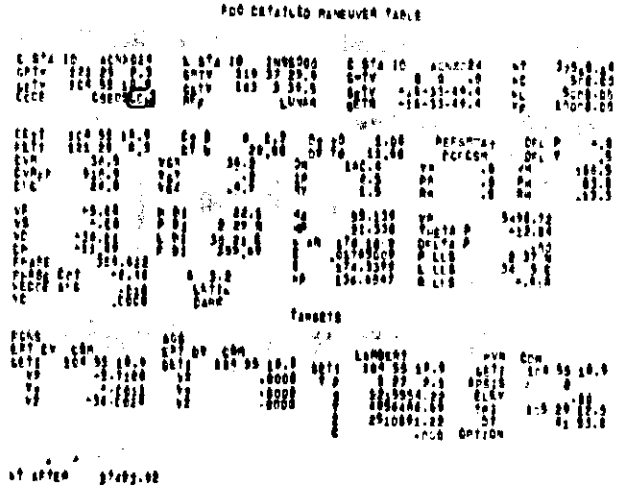
FDO DETAILED MANEUVER TABLE

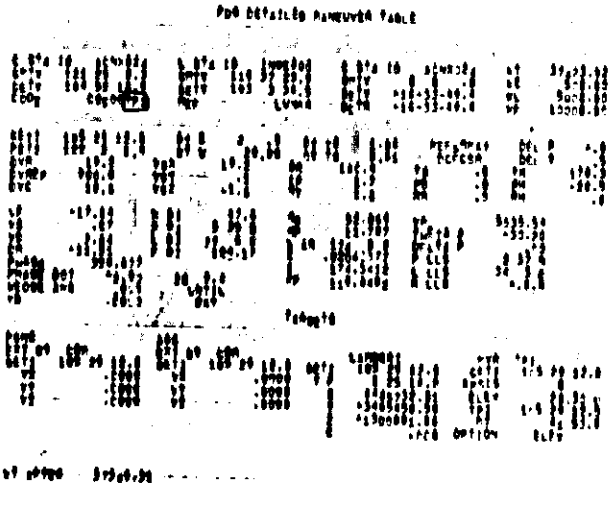


TARGETS

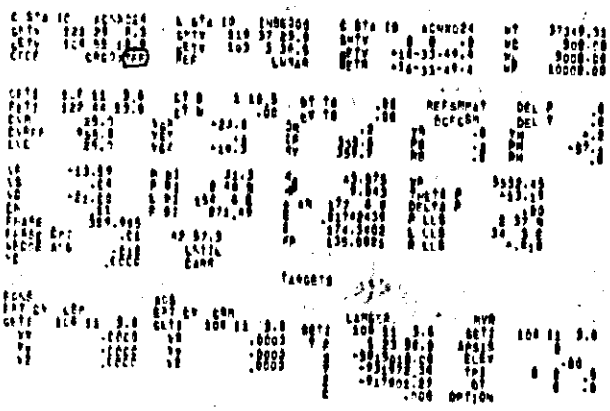


LT AFTER 37900.94


POD DETAILED MANEUVER TABLE

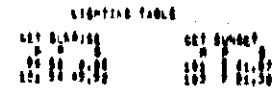

POD DETAILED MANEUVER TABLE

FDO DETAILED MANEUVER TABLE



10.3 SUNRISE-SUNSET TABLES

SR LIGHTING TABLE



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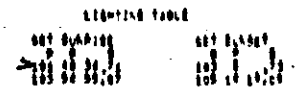
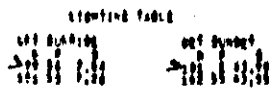
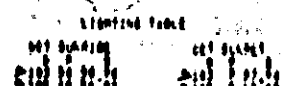






CSM LIGHTING TABLE

LIGHTING TABLE

SET BLANKING			SET BLANKS		
	P	Y		P	Y
>95	96	0.01	101	0	48.00
101	96	43.32	103	0	55.76
103	33	72.48	103	0	55.68
105	32	1.03	107	0	59.03
107	52	42.77	109	0	57.17

THE CSM HAS BEEN PARALYZED
PLUMCRK CSM 37 0 OPT OF 100 91 89.5
GET PC 103 57 39.0

LIGHTING TABLE

SET BLANKING			SET BLANKS		
	P	Y		P	Y
103	43	39.74	105	0	51.74
107	43	51.14	104	98	51.94

THE CSM HAS BEEN PARALYZED
PLUMCRK CSM 37 0 OPT OF 101 89 8.5
GET PC 104 55 10.0

LIGHTING TABLE

SET BLANKING			SET BLANKS		
	P	Y		P	Y
105	48	6.74	>105	0	32.74
107	43	57.41	110	93	39.96

THE CSM HAS BEEN PARALYZED
PLUMCRK CSM 37 0 OPT OF 120 3 1.4
GET PC 108 89 12.0

(Continued)

LIGHTING TABLE

SET BLANKING			SET BLANKS		
	P	Y		P	Y
>105	49	PC.74	106	84	52.74
107	43	0.12	108	84	57.91

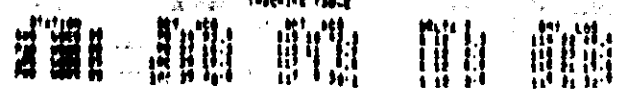
THE CSM HAS BEEN PARALYZED
PLUMCRK TPI 37 0 OPT OF 122 44 55.4
GET PC 120 81 9.8

LIGHTING TABLE

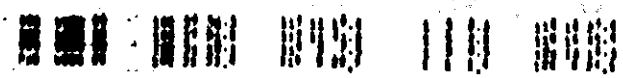
SET BLANKING			SET BLANKS		
	P	Y		P	Y
>107	42	41.93	>110	84	38.34
>109	38	42.04	>110	87	1.02

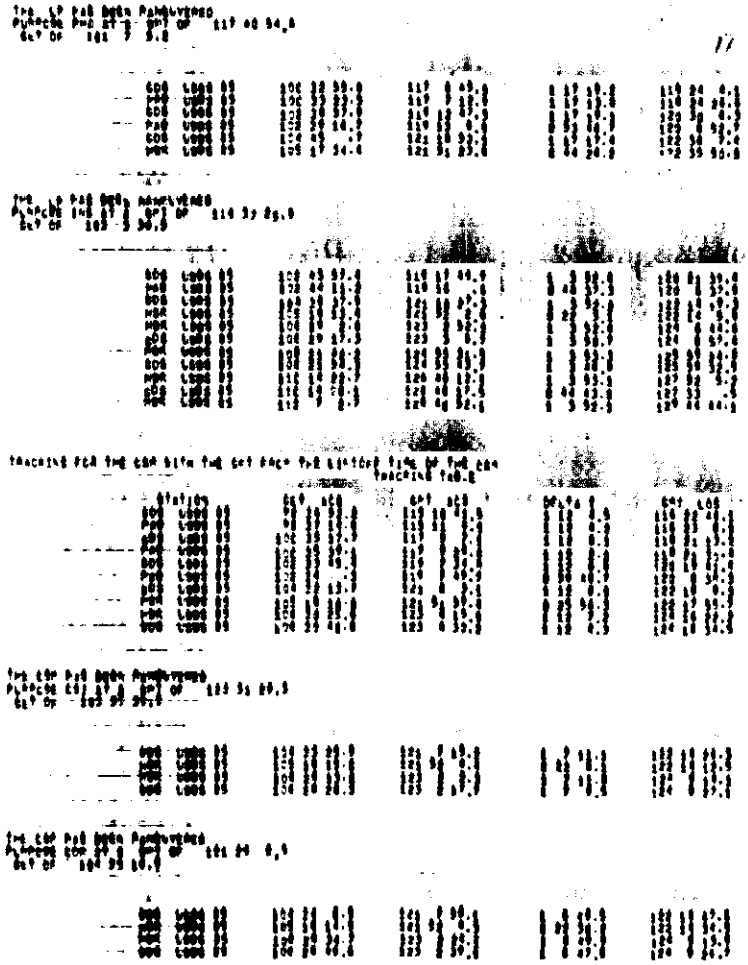
10.4 MSFN DEEP SPACE TRACKING

TRACKING FOR THE LO 51TH THE OUT PHASE THE LITTLE 51% OF THE CSM TRACKING FOR



THE LO HAS BEEN PARALYZED
GET PC 84 94 94.1





[illegible]

[illegible]

[illegible]

REFERENCE

1. Alexander, James D.; Bell, Jerome A.; and DuPont, Allan L.: Operational IM Abort and Rescue Plan for Apollo 10 (Mission F), Volume I - Nontime-Critical Procedures. MSC IN 69-FM-84, April 10, 1969.

END

DATE

FILMED

JUNE 12

1969